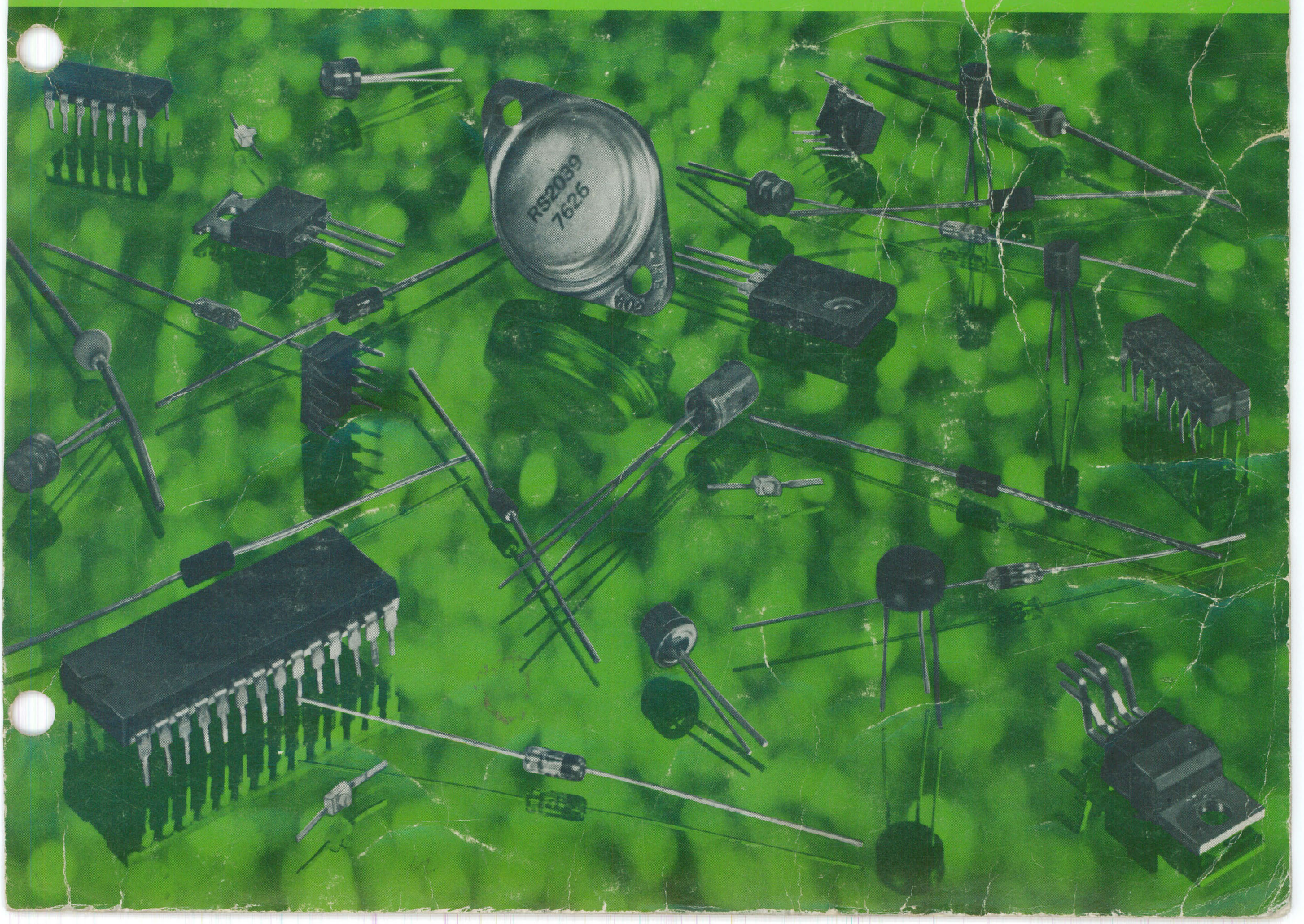
ARCHER®

Cat. No. 276-4004

1981 EDITION

Semiconductor Replacement Guide

INCLUDES OVER 118,000 SEMICONDUCTOR SUBSTITUTIONS



INTEGRATED CIRCUIT CROSS REFERENCE BY GENERIC AND CATALOG NUMBER

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LM386	276-1731	72	TL081C	276-1716	69-70	741	276-007	75	7473	276-1803	85
LM566	276-1724	74	TL084CN	276-1714	71	1458	276-038	76	7474	276-1818	85
LM567	276-1721	74	74LS00	276-1900	92	2102L	276-2501	81	7475	276-1806	86
LM1877N-9	276-702	55-56	74LS02	276-1902	92	2114L	276-2504	82	7476	276-1818	86
LM3914	276-1707	55-59	74LS04	276-1904	92	3900	276-1713	76-77	7490	276-1808	87
LM3915	276-1708	57-59	74LS08	276-1908	92	3909	276-1705	78	7492	276-1819	88
MA1026	277-1006	21-23	74LS32	276-1915	92	4001	276-2401	36	7805	276-1770	79
MC14553	276-2498	34	74LS73	276-1918	92	4011	276-2411	36	7812	276-1771	79
MM5290	276-2505	80	74LS74	276-1919	92	4013	276-2413	37	7815	276-1772	79
MM5369	276-1769	35	74LS75	276-1920	92	4017	276-2417	38	74154	276-1834	89
MM5871	276-1785	60	74LS90	276-1923	92	4027	276-2427	37	74192	276-1831	90
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INTRODUCTION

This SEMICONDUCTOR REFERENCE HANDBOOK is intended to be just that—a reference handbook. It is not a definitive text book on semiconductors. It is a compilation of data on Radio Shack's line of prime-quality ARCHER semiconductors. Every ARCHER device covered in this Handbook is guaranteed prime—they are not "fall-outs" or "seconds"; all are top-quality, with known JEDEC, EIA or manufacturer's numbers.

At the back of the book is a cross-reference listing for replacement of Transistors, Diodes and other interchangeable semiconductor devices. The total number of cross-referenced devices exceeds 118,000. These cross-reference/replacement listings are computer-selected and are based on careful analysis of important parameters of the listed devices.

NOTE: If you can't find a replacement listing for a device you require, refer to the specification listings of the appropriate ARCHER family device. Often you will be able to make suitable replacements based on the information presented.

Each ARCHER replacement should meet or exceed the required parameters. However, due to differences in Quality Control and Manufacturing procedures (which often allow for or result in broad parameter variations), and because many of the ARCHER devices are capable of better performance than the original, Radio Shack does not guarantee, nor does it imply, that the listed items will provide an exact replacement in **every** instance. Therefore we recommend that you check the voltage and current requirements of the circuit (and other pertinent specifications) before replacement and compare with the specifications listed for that particular ARCHER device.

HOW TO USE THIS BOOK

This book has been prepared to aid in BOTH replacement and original applications of Semiconductor devices. The information included will be invaluable for the service technician as well as the circuit designer (whether he be an engineer, hobbyist, student or electronics experimeter).

We have included hints on handling Semiconductor devices, operating considerations, and some simple tests to aid you in evaluating the quality of the device in existing equipment (and thus the need for replacement). Also, a complete section on the specifications for each of the ARCHER devices is included; if there is any question in your mind about replacement equivalents or original use, refer to the appropriate category in the book. You will find the important characteristics specified there.

The next to last section is an extensive listing of replacement and cross reference between other manufacturer's numbers (both JEDEC/EIA 2N—numbers and in-house designations) and the ARCHER devices. This listing provides for the substitution of over 118,000 semiconductors with ARCHER devices.

The final section includes case style drawings and some handy reference notes, a comprehensive glossary of commonly used words, plus symbols and abbreviations.

CARE AND HANDLING OF TRANSISTORS

Most modern transistors are somewhat immune from mechanical shock; however, it is always a good idea to keep them from excessive mechanical shocks, especially the metal-case type (avoid dropping, etc).

When cutting transistor leads, use scissor-type cutting tools (rather than diagonal cutting tools which use a crimping action). Crimp-type cutting tools produce a mechanical shock along the lead which when transmitted to the semiconductor chip or material can cause fracture. Consider the force with which the cut lead flies off the crimp-type cutting tool and you have a good idea of the intensity of the equal and opposite force which acts on the lead going into the device.

It is always a good practice to use a heat-sink tool on a transistor lead when soldering (use a low-wattage iron—30-watts or less). Heat from soldering can cause problems (especially with certain types of semiconductor devices). Thus, to be sure, always use a heat-sink on the lead when soldering. Gripping the lead with long nose pliers between the solder connection and the case of the device makes a good heat-sink; or use a tool designed for such use.

SILICON OR GERMANIUM?

The quickest way to determine if a transistor is germanium or silicon type, is to check the normal emitter-base voltage drop. With NPN devices, if the base is approximately 0.25 volts positive with respect to the emitter, it is a germanium type. If the voltage is about 0.65 volts, it is a silicon type. For PNP devices, the voltage will be the same value, but opposite in polarity (0.25 volts for germanium and 0.65 for silicon).

OPERATING CONSIDERATIONS

Before replacing an original-equipment device with the recommended Archer Type:

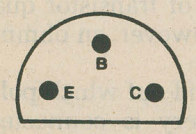
(A) Compare the lead or terminal arrangement of the Archer replacement device with the lead or ter-

minal arrangement of the original device. If these arrangements are different, and the original transistor is a "plug in" type, bend the leads of the ARCHER device so that the base, emitter and collector leads will mate with the original transistor leads. Trim the leads after soldering in place.

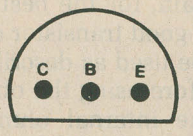
CAUTION: Be particularly careful about "pin-circle" and "in-line" lead break-out type transistors. Often one manufacturer makes a type with "in-line" leads, while another may make the same type with "pin-circle" configuration. **Doublecheck both the original and the replacement device before soldering or plugging in transistors.**

BOTTOM VIEW

PIN-CIRCLE



IN-LINE



(B) Certain considerations are involved whenever an original equipment transistor is replaced by one having a different type designation. When an ARCHER series transistor is used to replace an original equipment device in an untuned amplifier stage operating at a low signal level such as the untuned RF-amplifier (antenna) stage of a radio receiver, or a low-level AF amplifier stage, it is generally unnecessary to make any circuit adjustment to assure proper performance of the equipment. However, when a replacement is made in a turned RF amplifier stage, it is always advisable to check the alignment of the associated tuned circuits to assure proper tracking and to achieve the required gain without loss of stability.

(C) When replacements are made in stages operating at relatively high power levels, such as Class A and Class B AF output stages of automobile radio receivers, phonographs and AF-amplifier systems, the transistor bias should be checked and adjusted, if necessary, to protect the ARCHER replacement transistors against excessive dissipation and to minimize distortion. Means for making adjustments are generally provided in the equipment, and the necessary instructions are usually given in the equipment manufacturer's service data.

(D) When installing an ARCHER transistor as a substitute for an original equipment type in an FM tuner, TV tuner, or other circuits operating at frequencies in the VHF or UHF regions, it is extremely important not to change any of the lead lengths or position of the original circuit. Before removing the original transistor, carefully note its position with respect to other circuit components as well as the lengths and placement of the transistor leads, and duplicate these details as closely as possible with the ARCHER replacement transistor. Failure to observe this precaution can result in improper tuning or circuit instability. The same holds true for any replacement of Integrated Circuits, specially in FM radios and TV Receivers. Failure to observe this precaution can result in damage in the device. Transistor substitution in tuned circuits will often require realignment of the circuit.

SILICON VS SELENIUM RECTIFIERS

Silicon rectifiers are inherently more efficient than selenium or other metallic-oxide type rectifiers. When a silicon rectifier is used to replace a selenium rectifier in the power supply of a typical line-operated radio or TV receiver, the silicon rectifier will frequently deliver higher DC output voltage than the original device.

In some cases, this higher supply voltage may improve the performance of the equipment. However, in many other cases, it may immediately or eventually damage filter capacitors and/or other components which were designed to withstand only the voltage delivered by the original selenium rectifier. To prevent such damage, it is generally advisable to insert a power type resistor in series with the silicon rectifier either on the input side, between the AC supply and the rectifier, or on the output side between the rectifier and the first filter capacitor. The value of this resistor will depend on the required reduction in the DC output voltage and on the DC load current of the equipment. This value may be determined experimentally or calculated from the equation:

$$R = \frac{E}{I}$$

where R is the required resistance in ohms, E the required reduction in DC output voltage in volts and I the DC load current in amperes.

The wattage rating of the resistor should be at least 2 X EI (in no case less than 10 watts).

SOLDERING PRECAUTIONS

Extreme care should always be used in making solder connections to semiconductors. Momentary application of excessive heat, or even prolonged application of a properly heated soldering tool to a semiconductor lead or terminal, can permanently damage the device. Observe the following precautions in soldering a semiconductor lead or terminal:

1. Solder as far as possible from the body of the semiconductor.
2. Never, apply heat or molten solder to a lead or terminal for longer than 10 seconds or at a point closer than 1/16 inch to the body of the device.
3. Use a low voltage iron (30 watts or less) specifically intended for use with transistors or miniature circuit components.
4. Keep the surfaces to be soldered clean and the tip of the soldering tool adequately tinned so that the connection can be made as quickly as possible.
5. Always use a heat sink on the lead when soldering. Gripping the lead or terminal with longnose pliers between the solder connection and case or body allows the pliers to act as a heat sink, conducting heat away from the internal elements of the device.

ABOUT CASE DIMENSIONS

In some instances, the case of an ARCHER Semi-

conductor may be slightly taller or thicker than that of the original device or have a slightly different shape, particularly if the original device is a foreign type not made to U.S.A. EIA (JEDEC) standards. These mechanical differences should not affect the performance of the equipment in which the replacement is made and normally will not prevent or complicate the installation of the ARCHER replacement device.

You should realize that cross-reference substitution listings are created based **on electrical parameters (not necessarily on mechanical size or type).** Thus, when you make substitutions based on our listings, check for physical/mechanical compatibility. If space is limited, it would be a good idea to check physical dimensions as well as electrical specs before making substitution.

GENERAL PRECAUTIONS

ARCHER transistor and ARCHER semiconductors should not be inserted or withdrawn from circuits with the power on, because transient currents may cause permanent damage to the device. In some cases ARCHER semiconductors are in metal cans and thus could possibly become shock hazards if they are allowed to operate at a voltage appreciably above or below ground potential.

For the most effective protection, a power transistor should be operated with an adequate heat sink and with the lowest value of resistance or impedance in the emitter-to-base circuit consistent with driving signal considerations. The transistor should be protected against extremely high collector voltage pulses which may be generated when the device is operated with inductive loads particularly when current transients are present.

When replacing a power transistor or rectifier which is attached to the equipment chassis, or to a special heat sink, observe the following precautions:

A. In the case of oxide coated metal washers or wafers, which are frequently used as electrical insulators between the cases of power transistors and the chassis or heat sink, it is important not to scratch, chip or otherwise damage the oxide surface.

B. When installing an ARCHER power transistor, where a mica or oxide coated metal washer was used to insulate the case of the original device electrically from the case, apply a thin coating of Heat Sink Compound (Radio Shack Number 276-1372) between the washer and the chassis or heat sink.

TESTING A TRANSISTOR

Before replacing a transistor you want to be sure it needs to be replaced. Always check the entire circuitry to be sure the transistor requires replacement.

The best method for checking transistors is to use a good transistor checker (dynamic in-circuit and out-of-circuit type). However, a sensitive VOM can give you a good indication of the quality of the device.

I. In-Circuit Testing

A. First, check to see if the emitter-base junction is forward-biased. An NPN transistor should show the base 0.2 to 0.65 volts positive with respect to the emitter (approximately 0.25 volts for a germanium type and 0.6 volts for silicon). A PNP transistor should show the base 0.2 to 0.65 volts negative with respect to the emitter (0.25 volts for germanium and 0.6 volts for silicon).

B. Check to see if the device is functioning as an amplifier. Short the emitter-base junction to remove forward bias. Voltage at the collector lead should rise to approximately the potential of the collector supply buss line. Any difference is caused by ICES (collector-to-base leakage current). The closer the collector voltage approaches the buss line, the lower ICES is and the better the transistor.

II. Out-of-Circuit Testing

Again, for the best indication of transistor quality, use a good transistor checker. However, an ohmmeter can be used as described here.

Before using the ohmmeter, find out which polarity of the internal ohmmeter battery is connected to which test lead (not all ohmmeters have the + battery polarity connected to the red lead and the − battery polarity connected to the black lead). To determine the polarity of the leads when using the ohmmeter function, use an external voltmeter or study the schematic of your VOM.

Also, remember that in most transistor circuits you are dealing with low voltages and currents (in some cases, very low). Therefore, **NEVER** use RX1 scale (extensive currents can flow through a junction, permanently damaging the transistor). It is best to determine the maximum amount of current available in each resistance range before using an ohmmeter for testing semiconductor junctions.

After you have evaluated your VOM for the above and are sure you will not damage a transistor (with excessive current or voltage in any given ohmmeter range), proceed as follows:

A. Small Signal PNP Germanium Transistors
   1. Connect the positive lead of your ohmmeter to the emitter. Connect the negative lead to the base. You should read 200-500 ohms.
   2. Connect the negative lead to the collector. You should read 10K-100K. Shorting collector base, the resistance should decrease.

B. Small Signal NPN Germanium Transistors
   Reverse the polarity of the leads; the readings should be approximately the same.

C. Power PNP Germanium Transistors
   1. Connect the positive lead to the emitter. Connect the negative lead to the base. The reading should be 35-50 ohms.
   2. Connect the negative lead to the collector The reading should be several hundred ohms. Shorting collector to base, the resistance should decrease.

D. Power NPN Germanium Transistors
   Reverse the polarity of the leads; the reading should be approximately the same.

E. Small Signal PNP Silicon Transistors
   1. Connect the positive lead to the emitter. Connect the negative lead to the base. The reading should be 1K-3K.
   2. Connect the negative lead to the collector. The reading should be very high (may show as an "open").

F. Small Signal NPN Silicon Transistors
   Reverse the polarity of the leads; the readings should be approximately the same.

G. Power PNP Silicon Transistors
   1. Connect the positive lead to the emitter. Connect the negative lead to the base. The reading should be 200-1K.
   2. Connect the negative lead to the collector. The reading should be about 1 megohm or more.

H. Power NPN Silicon Transistors
   Reverse the polarity of the leads; the readings should be approximately the same.

The resistance readings noted above can only be approximate; as long as you obtain somewhat **proportionate** readings (emitter-base readings as compared to emitter-collector), you can safely assume the transistor is OK.

HANDLING OF INTEGRATED CIRCUITS

Because MOS devices have extremely high input resistance, they are susceptible to damage when exposed to static electrical charges (even electrical charges that normally build up on the human body can cause damage). To avoid possible damage to the devices during handling, testing, or actual operation, the following procedures should be observed:

1. Except when being tested or in actual operation, the leads of devices should be in contact with a conductive material, to avoid build-up of static charge.
2. Soldering iron tips, tools, metal parts of fixtures and handling facilities should be grounded.
3. Transient voltages may cause permanent damage to the device if it is removed or inserted with the power on.
4. Do not apply signals to the input with the power supply off.
5. All unused input leads must be connected to either V_{SS} or V_{DD} (whichever is appropriate for the logic circuit involved).

DIODES AND RECTIFIERS

GENERAL PURPOSE DIODES RATINGS @ 25°C

Catalog Number	PIV (min) V	If A	Ir (max) @ Vr μA	Vf (max) @ If V	Case Style
276-1101	50	1.0	10	1.6	DO41
276-1102	200	1.0	10	1.6	DO41
276-1103	400	1.0	10	1.6	DO41
276-1104	600	1.0	10	1.6	DO41
276-1114	1000	2.5	200	1.0	A1vm
276-1122	75	0.010	0.25	1.0	A1
276-1123	60	0.085	15	1.0	A1
276-1141	50	3.0	500	1.2	A3q
276-1143	200	3.0	500	1.2	A3q
276-1144	400	3.0	500	1.2	A3q

ZENER DIODES—1 Watt

Catalog Number	Vz Volts ±10%	Iz @ mA	Zz @ Iz ohms max	Case Style
276-561	6.2	41	2	A1 ay
276-562	9.1	25	7	A1 ay
276-563	12.0	21	9	A1 ay
276-564	15.0	17	14	A1 ay

BRIDGE RECTIFIERS

Catalog Number	PIV (min) V	If (max) A	Case Style
276-1146	50	4	M532a
276-1151	50	1.4	M548
276-1152	100	1.4	M548
276-1161	50	1	Y1
276-1171	100	4	M532a
276-1172	200	4	M532a
276-1173	400	4	M532a
276-1180	50	6	M532a
276-1185	50	25	—

TRANSISTORS

BIPOLAR

Catalog Number	Direct Commercial Equivalent	Mat.	Appli.	Polarity	Power Diss. @25°C Free Air	f_T Typical MHz	V_{CBO} V	V_{CEO} V	V_{EBO} V	I_C Max	I_B Max	h_{FE}	@V_{VE} V	@I_C mA	I_{CBO} at max V_{CB}	Case Style
276-2007	2N1305	G	S.	PNP	150mW	5	30	—	25	300mA		40	1	10	6μA	TO5
276-2008	SE7056	S	H.V.	NPN	1W	50	300	300	7	30ma		40	20	30	100na	TO92+
276-2009	MPS2222A	S	G.P.	NPN	500mW	300	75	40	6	800mA		50	10	1	10nA	TO92
276-2010	PN2484	S	LL	NPN	360mW	15	60	60	6	50mA		250	5	1	10nA	TO92
276-2011	MPS918	S	RF/IF	NPN	200mW	600	30	15	3	50mA		20	1	3	10nA	TO92
276-2013	2N5210	S	G.P.	NPN	350mW	30	50	50	4.5	50ma		250	5	1	50nA	TO92
276-2014	MPS3704	S	G.P.	NPN	360mW	100	50	30	5	800ma		100	2	50	100nA	TO92
276-2016	MPS3904	S	S	NPN	350mW	300	60	40	6	200mA		100	10	1	50nA	TO92
276-2017	TIP31	S	P	NPN	40W	3	40	40	5	3A	1A	10-50	4	3A	300μA	TO220
276-2018	TIP29	S	P.	NPN	40W	3	40	40	5	1A	400M	15	4	1A	300μA	TO220
276-1019	TIP33	S	P.	NPN	90W	3	40	40	5	10A	3A	20	4	3A	700μA	TO220
276-2020	TIP3055	S	P.	NPN	90W	3	100	70	7	15A	7A	20	4	4A	1mA	TO220
276-2021	MPS3640	S	RF/IF	PNP	350mW	500	12	12	4	80mA		30	0.3	10	10nA	TO92
276-2023	MPS2907	S	S.	PNP	400mW	200	60	40	5	600mA		50	10	1	20nA	TO92
276-2024	MPS3702	S	G.P.	PNP	360mW	100	40	25	5	200mA		60	5	50	0.5μA	TO92
276-2025	TIP32	S	P.	PNP	40W	3	40	46	5	3A	1A	10-50	4	3A	200μA	TO220
276-2026	TIP30	S	P.	PNP	40W	3	40	40	5	1A	400M	15	4	1A	300μA	TO220
276-2027	MJE34	S	P.	PNP	90W	3	40	40	5	10A	3A	20-100	4	3A	200μA	TO220
276-2030	2N3053	S	P.	NPN	1W	100	60	40	5	700mA		50	10	150	—	TO5
276-2032	MPS3638	S	RF/IF	PNP	350mW	100	25	25	4	500mA		30	3	10	10nA	TO92
276-2033	2N3643	S	S.	NPN	350mW	200	60	30	5	500mA		100	10	150	50nA	TO92
276-2034	MPS3906	S	S.	PNP	350mW	250	40	40	5	200mA		100	10	1	50nA	TO92
276-2038	2N3866	S	RF	NPN	5W	500	60	30	3.5	400mA		100	5	50	100μA	TO39
276-2039	2N6569	S	P.	NPN	100W	15	45	40	5	12A	5A	100	4	1A	—	TO3
276-2040	2N6594	S	P.	PNP	100W	15	45	40	5	12A	5A	100	4	1A	—	TO3
276-2041	2N3055	S	P.	NPN	115W	2.5	100	60	7	15A	7A	50	4	1A	—	TO3
276-2042	2N6576	S	P*	NPN	120W	—	60	60	7	15A	250M	20,000	3	4A	—	TO3
276-2043	MJ2955	S	P.	PNP	150W	4	100	60	7	15A	7A	70	10	.5	—	TO3
276-2047	2SD287A	S	P.	NPN	100W	15	200	120	7	10A	—	40-200	5	2	100μA	TO-3
276-2048	2SD313	S	P.	NPN	30W	8	60	60	5	3A	—	40-320	2	1	100μA	TO-220
276-2049	2SB596	S	P.	PNP	30W	3	80	80	5	4A	3A	40-240	5	500	30μA	TO-220
276-2050	2SA733	S	G.P.	PNP	250mW	180	50	40	5	100mA	—	40-600	6	1	100nA	TO-92
276-2051	2SC945	S	G.P.	NPN	250mW	250	60	50	5	100mA	—	60-600	6	1	100nA	TO-92
276-2052	2SC1096	S	P.	NPN	10W	60	40	30	5	3A	—	40-250	5	1A	100μA	TO-220
276-2053	2SC1307	S	RF	NPN	25W	180	70	45	4	8	—	20-150	10	2A	20μA	TO-220

NOTE: All ratings given are for 25°C except where otherwise noted.

MATERIAL:

S—Silicon; G—Germanium

APPLICATION:

S—Switch L.L.—Low Level RF—RF power *—High Gain Darlington

G.P.—General purpose P—Power amp/switch H.V.—High voltage

FIELD EFFECT

Catalog Number	Direct Commercial Equivalent	Circuit Application	N Channel	P Channel	Max. Power Diss. mW	Vdss V (max)	Vgss V (max)	g_{fs} mhos min/max	Case Style
276-2028	2N3821	Small Signal VHF Mixer and AMP	X		330	50	50	1.5m/4.5m	TO92
276-2035	2N3819	Small Signal General Purpose	X		360	25	25	2.0n/6.5m	TO92
276-2036	2N3823	RF Amp to 200 MHz	X		300	30	30	3.5m/6.5m	TO72a
276-2045	3N211	TV IF, Dual Gate MOSFET	X		360	27	35	17m/40m	TO-72b
276-2046	2SK212	FM Tuner	X		200	20	20	2.0m/6.0m	Y2
276-2070	VN10KM	VMOS Power FET	X		1W	60	60	100m/200m	TO-92+
276-2071	VN67AF	VMOS Power FET	X		15W	60	60	250m(typ)	TO-202AA

NOTE: All parameters are at 25°C.

UNIJUNCTION

Catalog Number	Direct Comm. Equivalent	Max Power Diss.	r_{BB} (max)	n (max)	V_{EB1} (sat)	V_{OB1} (min)	I_p (max)	Case Style
276-2029	MU4891	360mW	9.1K	0.82	4.0V	3.0V	5.0μA	X55

SPECIAL PURPOSE DEVICES

SCR'S

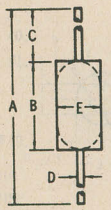
Catalog Number	Imax A	Vmax V	I_{GT} (max) mA	V_{GT} (max) V	Case Style
276-1067	6	200	25	1.5	MU27
276-1020	6	400	25	1.5	MU27

TRIAC'S

Catalog Number	Imax A	Vmax V	I_{GT} (max) mA	V_{GT} (max) V	Case Style
276-1001	6	200	50	2.5	TO220AB
276-1000	6	400	50	2.5	MU27

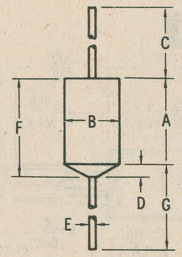
QUICK REFERENCE: CASE STYLE

A1

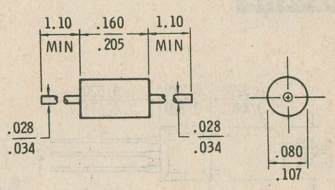


MAY SHOW COLOR BANDS TO DENOTE POLARITY.

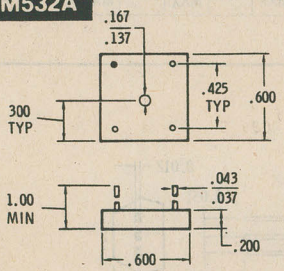
A3



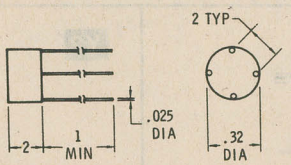
DO41



M532A

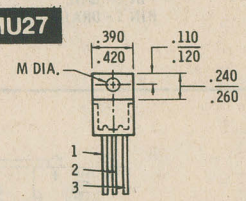


M548



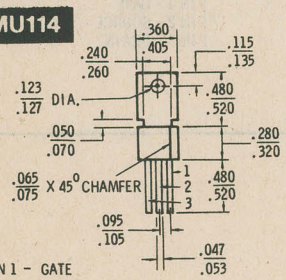
POS RED OR SQUARE LEAD.

MU27



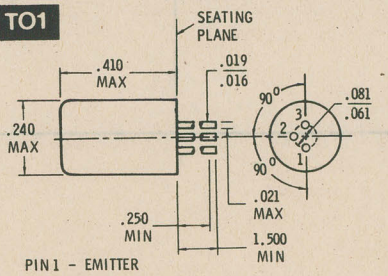
SCR	TRIAC
PIN 1 – CATHODE	ANODE 1
PIN 2 – ANODE	ANODE 2
PIN 3 – GATE	GATE

MU114



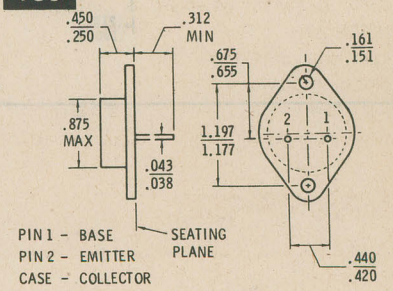
PIN 1 – GATE
PIN 2 – ANODE
PIN 3 – CATHODE

TO1



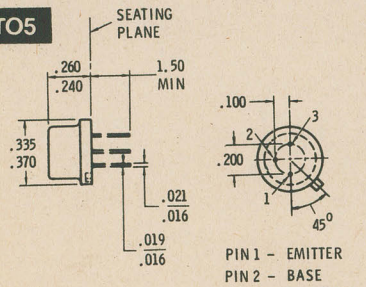
PIN 1 – EMITTER
PIN 2 – BASE
PIN 3 – COLLECTOR

TO3



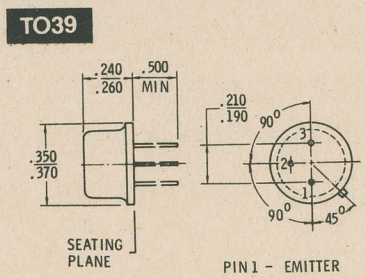
PIN 1 – BASE
PIN 2 – EMITTER
CASE – COLLECTOR

TO5



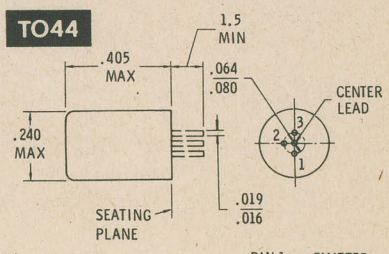
PIN 1 – EMITTER
PIN 2 – BASE
PIN 3 – COLLECTOR

TO39



PIN 1 – EMITTER
PIN 2 – BASE
PIN 3 – COLLECTOR

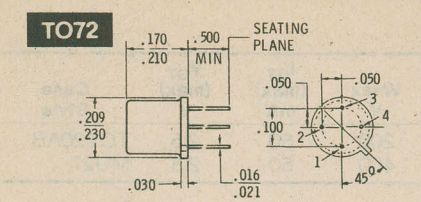
TO44



PIN 1 – EMITTER
PIN 2 – BASE
PIN 3 – COLLECTOR

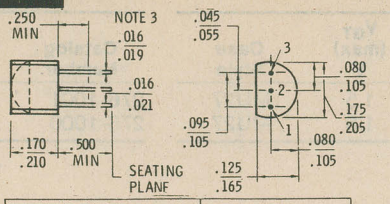
QUICK REFERENCE: CASE STYLE

TO72



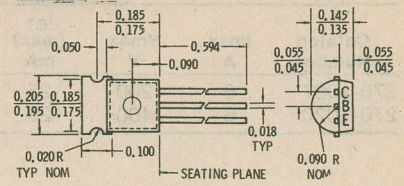
BIPLOAR TRANSISTORS	FET A	FET B
PIN 1 - EMITTER PIN 2 - BASE PIN 3 - COLLECTOR PIN 4 - CASE	PIN 1 - SOURCE PIN 2 - DRAIN PIN 3 - GATE PIN 4 - CASE	PIN 1 - DRAIN PIN 2 - GATE 2 PIN 3 - GATE 1 PIN 4 - SOURCE, CASE

TO92



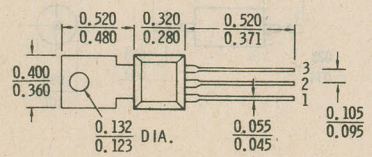
FET N-CHANNEL	PIN	FET P-CHANNEL	SCR	BIPOLAR
SOURCE	1	SOURCE	1-CATHODE	PIN 1 - E
GATE	2	DRAIN	2-GATE	PIN 2 - B
DRAIN	3	GATE	3-ANODE	PIN 3 - C

TO92 +



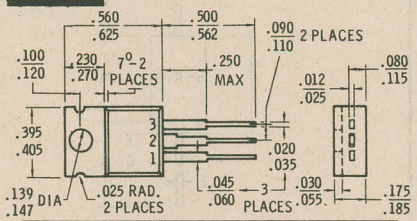
BIPOLAR TRANSISTORS	FET
PIN 1 - E PIN 2 - B PIN 3 - C	PIN 1 - SOURCE PIN 2 - GATE PIN 3 - DRAIN

TO202AA



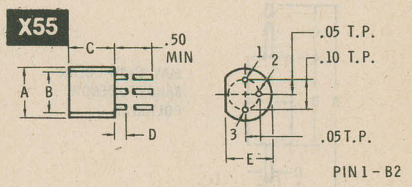
PIN 1 - SOURCE
PIN 2 - GATE
PIN 3 - DRAIN, TAB

TO220



BIPOLAR TRANSISTORS	TRIAC
PIN 1 - BASE	PIN 1 - ANODE 1
PIN 2 - COLLECTOR	PIN 2 - ANODE 2
PIN 3 - EMITTER	PIN 3 - GATE

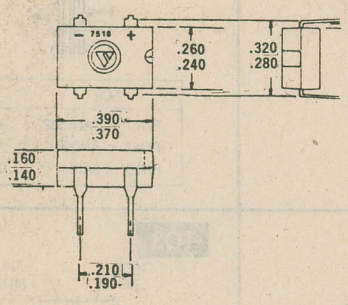
X55



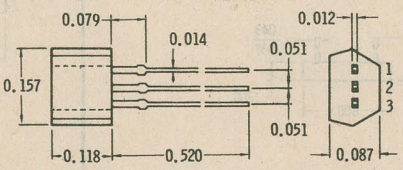
PIN 1 - B2
PIN 2 - E
PIN 3 - B1

	A	B	C	D	E
X55	.195 .205	.150 .170	.180 .190	.015	.155 .165
X55c	.200 MAX	.150	.177 MAX	.062	.149 MAX

Y1



Y2



PIN 1 - GATE
PIN 2 - SOURCE
PIN 3 - DRAIN

FLASHING RED LIGHT EMITTING DIODE

FRL-4403
276-036

GENERAL DESCRIPTION

The FRL-4403 is a gallium arsenide phosphide solid state lamp with a red diffused plastic lens. The built-in IC chip flashes the lamp on/off and can be driven by standard TTL and CMOS circuits, eliminating the need for additional switching circuitry. No external current limiting resistors are needed since the flasher IC is designed for direct operation from a standard 5VDC TTL power supply.

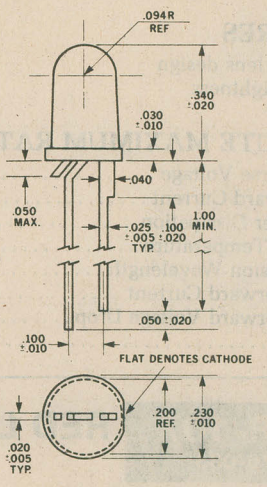
FEATURES

- Build-in IC chip, flashes lamp on and off to attract attention.
- Pulse rate 5 Hz
- T 1¾ size
- Large full flood radiating area
- High Brightness −1.2 mcd typ.
- TTL/CMOS compatible

ABSOLUTE MAXIMUM RATINGS

Operating Temperature ..... −55°C to +55°C
Storage Temperature ..... −55°C to 100°C
Lead Soldering Temperature ..... 5 sec @ 260°C
(1/16 Inch From Case)
Operating Voltage 5.25V
Peak Inverse Voltage 0.4V

PIN CONNECTION



$1.99 P 124

RED, GREEN & YELLOW LIGHT EMITTING DIODES

SEL-1120R
276-070

SEL-1320G
276-071

SEL-1720Y
276-072

GENERAL DESCRIPTION

Miniature, LED lamp with a diffused lens. Emits bright light with solid state reliability; is compatible with most TTL and transistor circuits.

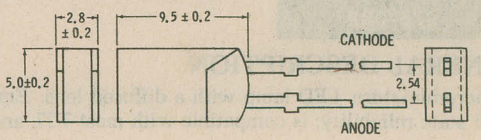
FEATURES

- High brightness
- Ideal for bar graph display
- Can be arranged horizontally or vertically

ABSOLUTE MAXIMUM RATINGS

Forward Current ..... 30 mA
Pulse Forward Current ..... 100 mA
Reverse Voltage 3V
Operating Temperature ..... −25 to +85°C

PIN CONNECTION



Dimensions are in mm

ELECTRICAL OPTICAL CHARACTERISTICS

	276-070	276-071	276-072
Peak Emission Wavelength	700 nM typ.	560 nM typ.	570 nM typ.
Brightness @ If= mA	0.7 mcd. typ.	0.7 mcd. typ.	0.2 mcd. typ.
Forward Voltage Drop @ If=10 mA	2.5V_{max}	3.0V_{max}	3.0V_{max}

2/$1.59 P 124

TLG-107 276-034 GREEN LIGHT EMITTING DIODE

GENERAL DESCRIPTION

Miniature, LED lamp with a diffused lens. Emits bright green light with solid state reliability; is compatible with most TTL and transistor circuits.

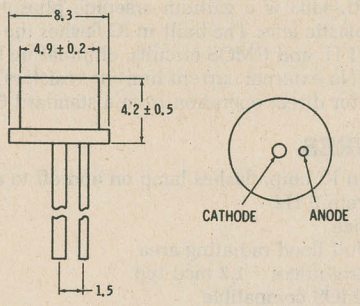
FEATURES

- Frensel lens design
- High brightness

ABSOLUTE MAXIMUM RATINGS

Peak Reverse Voltage	4.0 Vdc
Max. Forward Current	45 mA
Max. Power Dissipation	125 mW
Operating Temperature	−20°C to +75°C
Peak Emission Wavelength	560 nM
Typical Forward Current	20mA
Typical Forward Voltage Drop	2.0 Vdc
Brightness	1.2 mcd @ 20 mA typ.

PIN CONNECTION



Dimensions are in mm

2/$1.09

TLR-107 276-033 RED LIGHT EMITTING DIODE

GENERAL DESCRIPTION

Miniature, LED lamp with a diffused lens. Emits bright red light with solid state reliability; is compatible with most TTL and transistor circuits.

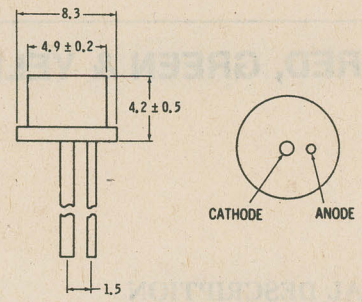
FEATURES

- Frensel lens design
- High brightness

ABSOLUTE MAXIMUM RATINGS

Peak Reverse Voltage	4.0 Vdc
Max. Forward Current	35 mA
Max. Power Dissipation	100 mW
Operating Temperature	−20°C to +75°C
Peak Emission Wavelength	700 nM
Typical Forward Current	20 mA
Typical Forward Voltage Drop	2.1 Vdc
Brightness	1.5 mcd @ 20 mA typ.

PIN CONNECTION



Dimensions are in mm

2/.99¢

TLR-121 276-032 RED LIGHT EMITTING DIODE

GENERAL DESCRIPTION

Microminiature, LED lamp with a diffused lens. Emits bright red light with solid state reliability; is compatible with most TTL and transistor circuits.

FEATURES

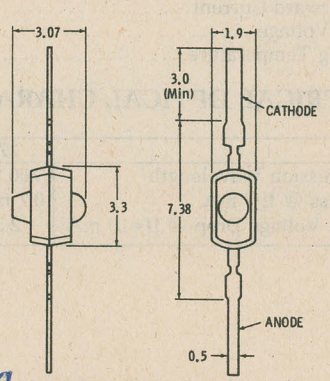
- Microminiature size fits tight PC boards
- Perfect for status, data, address indicators
- Low power with high intensity output

ABSOLUTE MAXIMUM RATINGS

Peak Reverse Voltage	4.0 Vdc
Max. Forward Current	15 mA
Max. Power Dissipation	60 mW
Operating Temperature	−20°C to +75°C
Peak Emission Wavelength	700 nM
Typical Forward Current	10 mA
Typical Forward Voltage Drop	2.0 Vdc
Brightness	0.7 mcd @ 10mA typ.

4/$1.49

PIN CONNECTION



Dimensions are in mm

P.124

TRI-COLOR LIGHT EMITTING DIODE

XC-5491
276-035

GENERAL DESCRIPTION

The XC-5491 tri-state lamp provides red, green, and yellow emission in the same package. This LED is a popular .200 diameter, two-leaded package containing a red and green LED chip in inverse parallel. By reversing the polarity of the applied current, the LED will emit red or green light while an AC voltage results in yellow light. The chips used in the XC-5491 are brightness matched so that the light output is uniform. This eliminates the necessity for the special drive circuits previously required with tri-state lamps.

These lamps provide the designer with the capability of efficiently displaying three functions with one indicator. This reduces the number of front panel indicators and simplifies design.

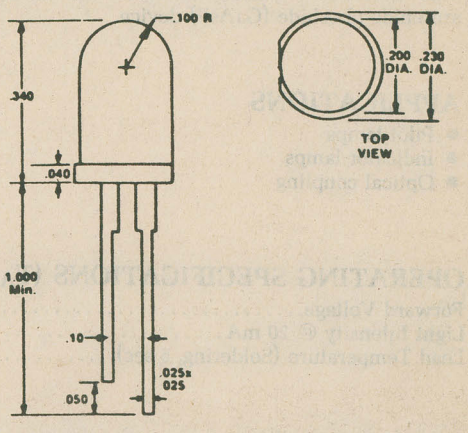
FEATURES

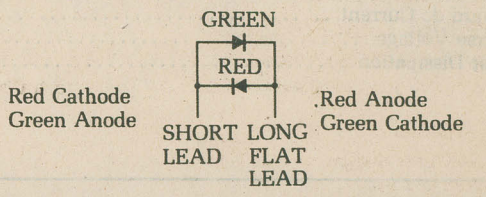
- 3 States—red, green, and yellow
- Equal brightness in all three colors
- Popular T 1¾ size package
- Wire wrappable leads

ABSOLUTE MAXIMUM RATINGS

Forward Current	25 mA
Peak Reverse Voltage	5V
Power Dissipation	100 mW
Operating Temperature Range	−55 to +85°C
Lead Solder Temperature	260°C

PIN CONNECTION





$2.79

RED LIGHT EMITTING DIODE

276-026

GENERAL DESCRIPTION

This LED contains diffusing particles in the plastic encapsulant. When the device on "ON," it appears as a large, soft light source, making it ideally suited for front panel applications.

FEATURES

- Minature T1 size
- Red LED with a frosted diffused lens.

APPLICATIONS

- Pilot lamps
- Optical coupling
- Indicator lamps

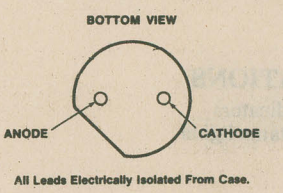
RADIANT CHARACTERISTICS IF=20mA (25°C)

Luminous Intensity	0.3 mcd
Luminous Flux	0.7 mcd
Wavelength @ Peak	650 nM
Rise and Fall Time	10 ns

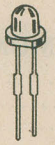
ABSOLUTE MAXIMUM RATINGS

Forward DC Current	50 mA
Peak Reverse Voltage	3 Volts
Power Dissipation-Derate 1.3 W/°C above 25°C	100 mW
Storage Temperature	−40°C to 100°C
Operating Temperature	−40°C to 70°C
Solder Temperature for 5 seconds	250°C @ 0.1" from Seating Plane

PIN CONNECTION



All Leads Electrically Isolated From Case.



3/2.59

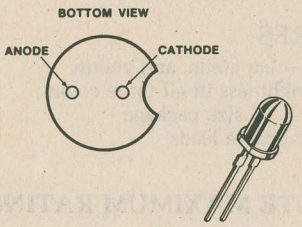
P. 124

276-041 RED LIGHT EMITTING DIODE

GENERAL DESCRIPTION

This device is a jumbo red LED with diffused lens, IC compatible-galliun aresenide phoshide (GaAsP) device.

PIN CONNECTION



APPLICATIONS

- Pilot lamps
- Indicator lamps
- Optical coupling

OPERATING SPECIFICATIONS (T_A @ 25°C)

Forward Voltage	1.75 V (typ)
Light Intensity @ 20 mA	1.0 mcd (typ)
Lead Temperature (Soldering, 5 sec)	260°C

ABSOLUTE MAXIMUM RATINGS (T_A @ 25°C)

Forward dc Current	70 mA
Reverse Voltage	3.0 V
Power Dissipation	140 mW

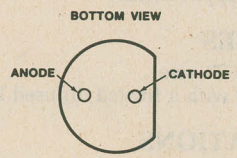
3/82.29

276-042 RED LIGHT EMITTING DIODE

GENERAL DESCRIPTION

Subminiature, red LED with a diffused lens. Emits bright light with solid state reliability; is compatible with most TTL and transistor circuits.

PIN CONNECTION



APPLICATIONS

- Visual indicators
- Data or status lights

OPERATING SPECIFICATIONS (TA @25°C)

Forward Voltage	1.6 V
Light Intensity @20mA	0.6mcd (typ)

ABSOLUTE MAXIMUM RATINGS

Reverse Voltage	3.0 V
Forward Current	40 mA
Power Dissipation	80mW
Storage Temperature	−40°C to 100°C
Operating Temperature	−40°C to 100°C
Solder Temperature for 5 seconds	250°C @0.1″ from Seating Plane

3/82.29

INFRARED EMITTER AND DETECTOR 276-142

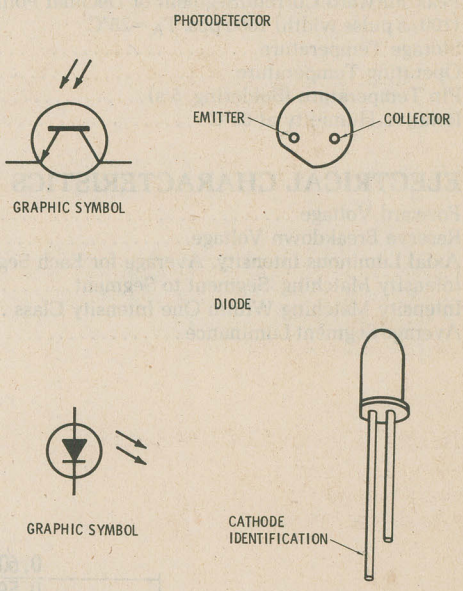
GENERAL DESCRIPTION

The 276-142 is a pair consisting of an infrared photodetector and an infrared-emitting diode. The diode is capable of emitting radiant energy in the infrared region of the spectrum.

FEATURES

- Designed for automatic or hand insertion in sockets or PC boards
- Recommended for industrial applications requiring low-cost discrete phototransistors
- Spectrally and mechanically matched
- Output spectrally compatible with silicon sensors
- High power efficiency . . . typically 5 percent at 25°C

PIN CONNECTION



ABSOLUTE MAXIMUM RATINGS (TA @25°)

Photodetector

Collector-Emitter Voltage	20V
Collector Current	25mA
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature	50mW
Operating Free-Air Temperature Range	−40°C to 80°C
Storage Temperature Range	−40°C to 85°C
Lead Temperature 1/16 Inch from Case for 5 Seconds	240°C

Infrared-Emitting Diode (red)

Reverse Voltage	2V
Continuous Forward Current	40mA
Radiant Power Output	0.5mW
Wavelength at Peak Emission	915mm

2.99 P124

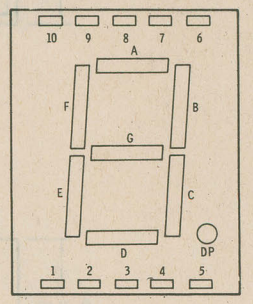
RED 0.5″ SEVEN SEGMENT NUMERIC DISPLAY

FND500 276-1647
FND507 276-1648

GENERAL DESCRIPTION

The FND500 & FND507 are red GaAsP Single Digit 7-segment displays with a 0.5-inch character height. The FND500 is common-cathode and FND507 is common-anode configuration. These displays are designed for applications in which the viewer is within twenty feet of the display.

PIN CONNECTIONS



FEATURES

- Low forward voltage—typically 1.7V
- Fits standard dip sockets with 0.6″ pin row
- Decimal point on lower right-hand side
- Overflow point on upper left-hand side with digit reversed
- Maximized contrast ratio with integral lens cap
- Horizontal stacking 0.6″ minimum, 1″ typical

PIN	FUNCTION
1	Segment E
2	Segment D
3	Common Anode
4	Segment C
5	Decimal Point
6	Segment B
7	Segment A
8	Common Anode
9	Segment F
10	Segment G

PIN	FUNCTION
1	Segment E
2	Segment D
3	Common Cathode
4	Segment C
5	Decimal Point
6	Segment B
7	Segment A
8	Common Cathode
9	Segment F
10	Segment G

2/$3.99 P123

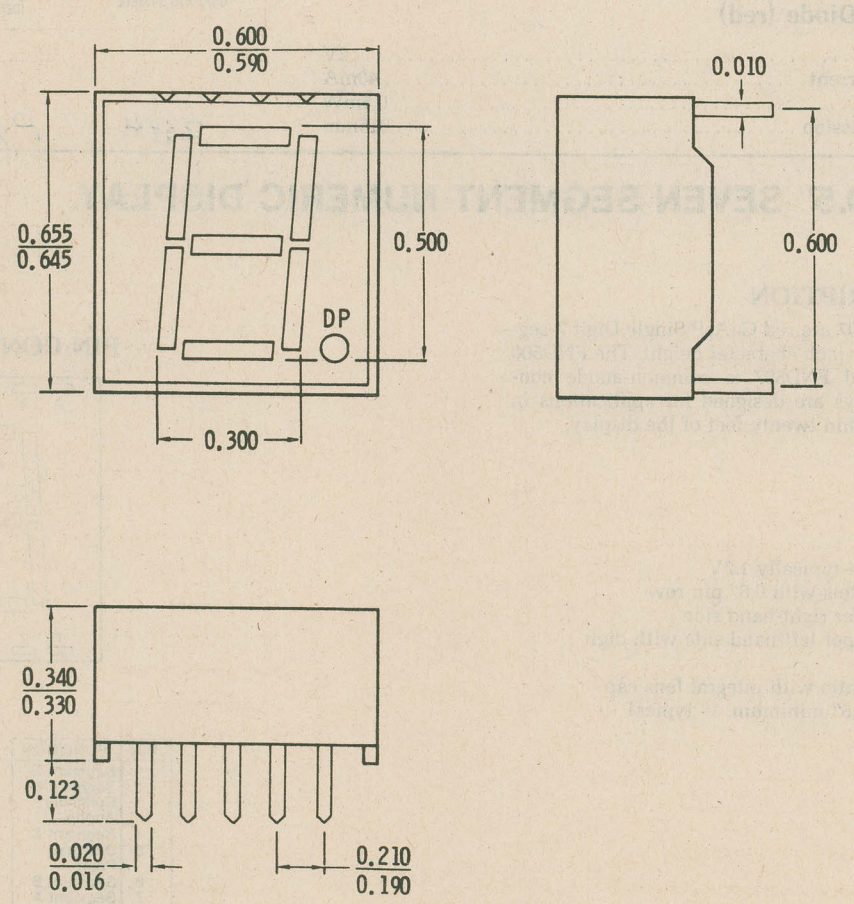
FND500 276-1647 FND507 276-1648

ABSOLUTE MAXIMUM RATINGS

Reverse Voltage	3.0V
Average Forward Current/Segment or Decimal Point	25mA
Derate from 25°C Ambient Temperature	0.3mA/°C
Peak Forward Current/Segment or Decimal Point (100 μs pulse width) 1000 pps, T_A =25°C	200mA
Storage Temperature	−25°C to +85°C
Operating Temperature	−25°C to +85°C
Pin Temperature (Soldering, 5 s)	260°C
Relative Humidity at 65°C	98%

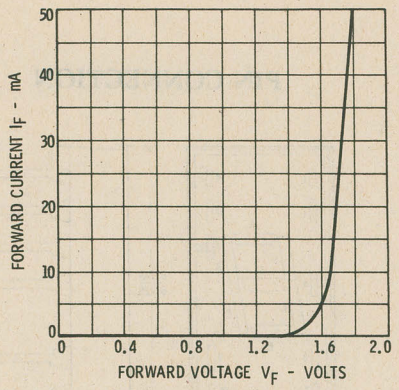
ELECTRICAL CHARACTERISTICS (Typical) I_F =20mA

Forward Voltage	1.7V
Reserve Breakdown Voltage	12V
Axial Luminous Intensity, Average for Each Segment	600ucd
Intensity Matching, Segment to Segment	±33%
Intensity Matching Within One Intensity Class	±20%
Average Segment Luminance	35f_tL

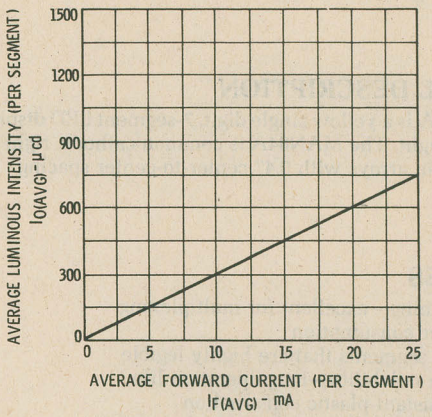


TYPICAL CHARACTERISTICS

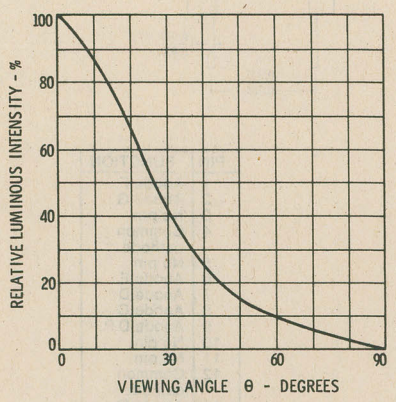
FND500 276-1647 **FND507** 276-1648



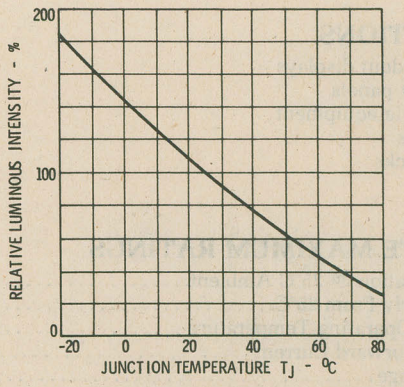
Forward Current vs Forward Voltage



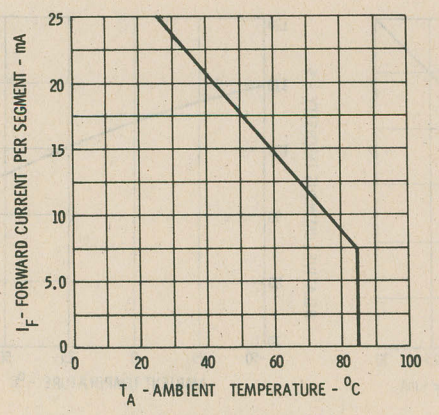
Average Luminous Intensity vs Average Forward Current



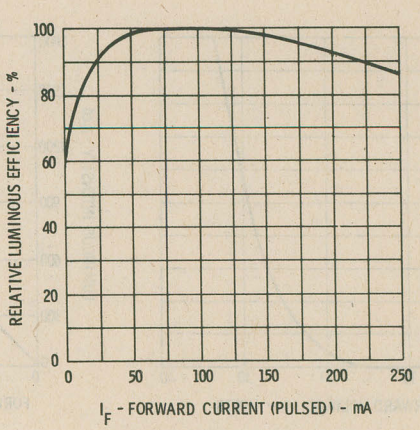
Angular Distribution of Luminous Intensity



Relative Luminous intensity vs Junction Temperature



Maximum Average Current Rating Versus Ambient Temperature



Relative Luminous Efficiency (mcd Per mA) Versus Peak Current Per Segment

MAN84A
276-067

YELLOW 0.3″ SEVEN SEGMENT DISPLAY

GENERAL DESCRIPTION

The MAN84A is a yellow single digit, 7-segment LED display with a nominal 0.3″ character height. The MAN84A is common cathode, right hand decimal and can be mounted in arrays with 0.4″ center-to-center spacing.

FEATURES

- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Standard 14 pin dual in-line package configuration
- Wide angle viewing . . . 150°

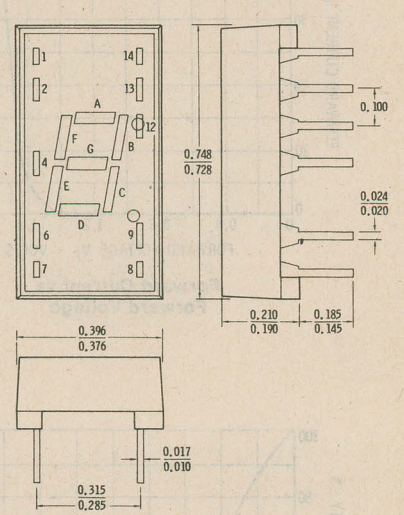
APPLICATIONS

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

ABSOLUTE MAXIMUM RATINGS

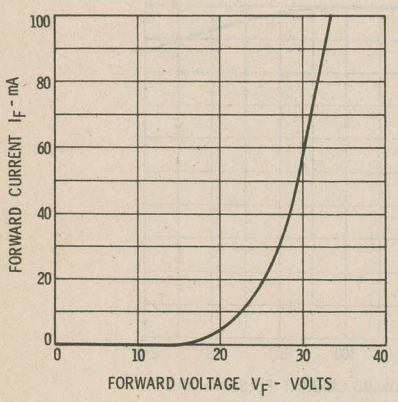
Power Dissipation @ 25°C Ambient	600mW
Derate Linearly From 25°C	−10.3mW/°C
Storage and Operating Temperature	−40°C to +85°C
Continuous Forward Current	200mA
Reverse Voltage	6.0V
Solder Time @ 260°C	5 sec.

PIN CONNECTION

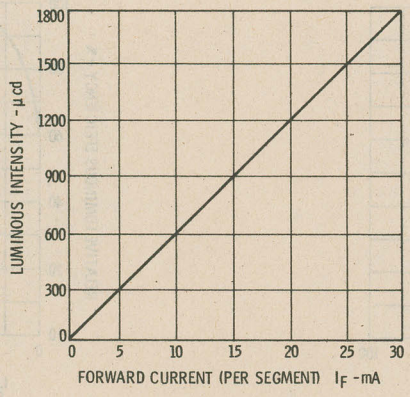


PIN	FUNCTION
1	Anode F
2	Anode G
3	No pin
4	Common cathode
5	No pin
6	Anode E
7	Anode D
8	Anode C
9	Anode D.P.
10	No pin
11	No pin
12	Common cathode
13	Anode B
14	Anode A

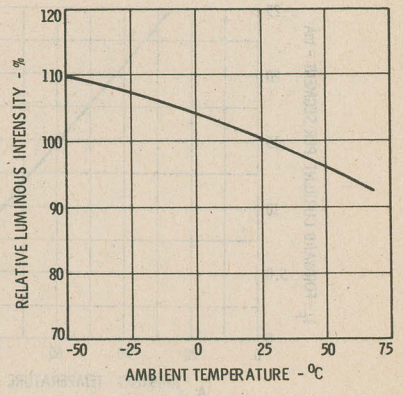
TYPICAL CHARACTERISTICS



Forward Current vs Forward Voltage



Luminous Intensity vs Forward Current



Luminous Intensity vs Temperature

2/$1.99

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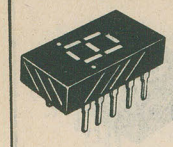


0.3" SOLID STATE SEVEN SEGMENT DISPLAY 276-053

GENERAL DESCRIPTION

The 276-053 is a common anode LED numeric display. The large 0.3" high character size generates a bright, continuously uniform 7 segment display. Designed for viewing distances of up to 10 feet, this single digit display has been human engineered to provide a high contrast ratio and wide viewing angle.

FEATURES

- Fits 14 pin DIP socket
- Excellent character appearance—continuous uniform segments; wide viewing angle; high contrast
- IC compatible—1.6 V per segment
- Standard 0.3" DIP lead configuration; PC board or standard socket mountable
- Both left and right decimal points

APPLICATIONS

- Electronic calculators
- TVs
- Radios
- Frequency counters
- Digital clocks

RADIANT CHARACTERISTICS (IF=20mA) T_A=25°C

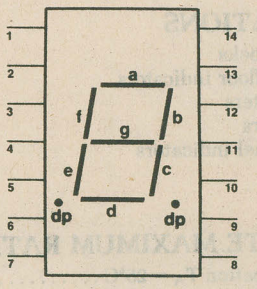
Luminous Intensity ..... 250 mcd
Wavelength (Peak) ..... 655 nM

ABSOLUTE MAXIMUM RATINGS

Power Dissipation T_A = 25°C ..... 400 mW
Operating Temperature Range ..... −20°C to 85°C
Storage Temperature Range ..... −20°C to 85°C
Average Forward Current/Segment or Decimal Pt. T_A = 25°C ..... 25 mA
Peak Forward Current/Segment or Decimal Pt. T_A = 25°C (Pulse Duration 500 us) ..... 150 mA
Reverse Voltage/Segment or Decimal Pt. ..... 6 V
Max Solder Temperature 1/16" Below Seating Plant (t≤5 sec.) ..... 230°C

PIN CONNECTION

TOP VIEW



276-053
COMMON ANODE

PIN	FUNCTION
1	CATHODE a
2	CATHODE f
3	ANODE
4	NO PIN
5	NO PIN
6	CATHODE dp
7	CATHODE e
8	CATHODE d
9	NO CONNECTION
10	CATHODE c
11	CATHODE g
12	NO PIN
13	CATHODE b
14	ANODE

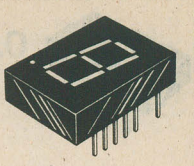
ALTERNATE CONNECTION

PIN	FUNCTION
1	NO PIN
2	ANODE
3	CATHODE-f
4	CATHODE-g
5	CATHODE-e
6	CATHODE-d
7	NO PIN
8	NO PIN
9	ANODE
10	CATHODE-dp
11	CATHODE-c
12	CATHODE-b
13	CATHODE-a
14	NO PIN

$ 3.79

D124

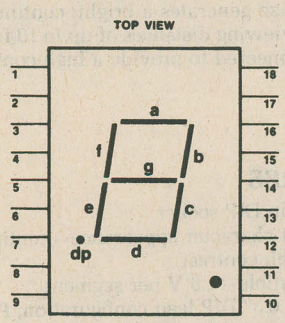
276-056 0.6" SEVEN SEGMENT NUMERIC DISPLAY



GENERAL DESCRIPTION

This device is a single digit numeric display. It is compatible with bipolar and MOS IC's. It provides fast switching—excellent for multiplexing—and the 0.6 inch character height provides a viewing distance up to 25 feet. This is a common anode display. Decimal point is on left.

PIN CONNECTION



APPLICATIONS

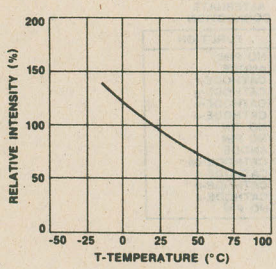
- Digital clocks
- Elevator floor indicators
- Panel meters
- Calculators
- TV channel indicators

ABSOLUTE MAXIMUM RATINGS

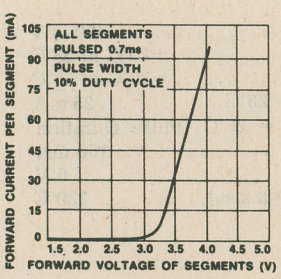
Power Dissipation $T_A = 25°C$ 960mW
Power Derate Factor from 25°C ..... −6.6 mW/°C
Storage and Operating Temperature ..... 0°C to 85°C
DC Current/Segment or DP, $T_A = 25°C$ ..... 30 mA
Average Current/Segment or DP, $T_A = 25°C$ ..... 25 mA
Peak Current/Segment or DP, $T_A = 25°C$ ..... 250 mA
Reverse Voltage/Segment ..... 6.0 V
Solder Temperature 1/16" Below Seating Plane, t≤5 Seconds ..... 240°C

TYPICAL CHARACTERISTICS

Light Intensity vs Ambient Temperature



Forward Current vs Forward Voltage



276-056

PIN	FUNCTION
1	NO PIN
2	CATHODE - a
3	CATHODE - f
4	ANODE*
5	CATHODE - e
6	ANODE*
7	CATHODE - dp
8	NO PIN
9	NO PIN
10	NO PIN
11	CATHODE - d
12	ANODE*
13	CATHODE - c
14	CATHODE - g
15	CATHODE - b
16	NO PIN
17	ANODE*
18	NO PIN

*Common redundant anodes

$4.99

A-124

OPTO-COUPLER TRANSISTOR OUTPUT

TIL111
276-132

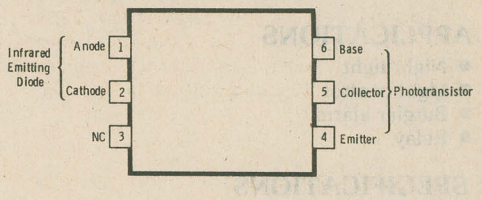
GENERAL DESCRIPTION

The TIL111 consists of a gallium arsenide infrared-emitting diode and an n-p-n silicon phototransistor mounted on a 6-lead frame encapsulated within an electrically nonconductive plastic compound. The case will withstand soldering temperature with no deformation and device performance characteristics remain stable when operated in high-humidity conditions.

FEATURES

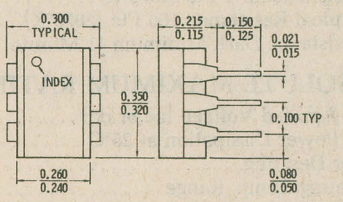
- Infrared source optically coupled to a silicon N-P-N phototransistor
- High direct-current transfer ratio
- Plastic dual-in-line package
- High-speed switching: $t_r = 5\ \mu s$, $t_f = 5\ \mu s$ typical

PIN CONNECTION



ABSOLUTE MAXIMUM RATINGS

Input-to-Output Voltage: TIL111 ..... ±1.5 kV
Collector-Base Voltage 70V
Collector-Emitter Voltage 30V
Emitter-Collector Voltage 7V
Emitter-Base Voltage 7V
Input-Diode Reverse Voltage 3V
Input-Diode Continuous Forward Current at (or below) 25°C Free-Air Temperature (See Note 2) 100mA
Forward Voltage 1.4V
Gain (Typical) 300
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature:
Total, Infrared-Emitting Diode plus Phototransistor 250mW
Storage Temperature Range ..... −55°C to 150°C
Lead Temperature 1,6 mm (1/16 Inch) from Case for 10 Seconds ..... 260°C
Switching Time, On or Off (Typical) 5μs



$1.99

OPTO-COUPLER DARLINGTON OUTPUT

TIL119
276-133

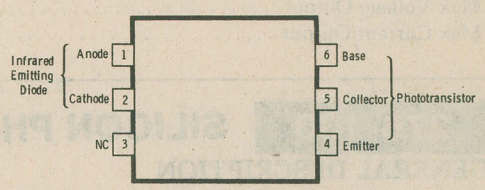
GENERAL DESCRIPTION

The TIL119 consists of a gallium arsenide infrared-emitting diode and an n-p-n silicon phototransistor mounted on a 6-lead frame encapsulated within an electrically nonconductive plastic compound. The case will withstand soldering temperature with no deformation and device performance characteristics remain stable when operated in high-humidity conditions.

FEATURES

- Infrared source optically coupled to a silicon N-P-N darlington-connected phototransistor
- High direct-current transfer ratio . . . 300% minimum at 10mA
- High-voltage electrical isolation . . . 1500-volt rating
- Plastic Dual-in-line Package

PIN CONNECTION

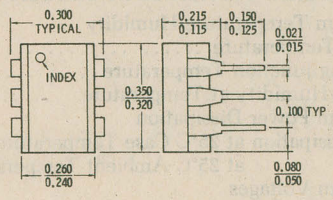


APPLICATIONS

- Remote termination isolation
- SCR and triac triggers
- Mechanical relays
- Pulse transformers

ABSOLUTE MAXIMUM RATINGS

Input-to-Output Voltage ..... ±1.5kV
Collector-Base Voltage 30V
Colletor-Emitter Voltage 30V
Emitter-Collector Voltage 7V
Input-Diode Reverse Voltage 3V
Input-Diode Continuous Forward Current at (or below) 25°C Free-Air Temperature 100mA
Forward Voltage 1.5V
Gain (Typical) 300
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature:
Total Infrared-Emitting Diode plus Phototransistor 250mW
Shortage Temperature Range ..... −55°C to 150°C
Lead Temperature 1,6 mm (1/16 Inch) from Case for 10 Seconds ..... 260°C
Switching Time, On or Off (Typical) 300μs



1.99

P.124

276-116 CADMIUM SULPHIDE PHOTOCELL

GENERAL DESCRIPTION

A cadmium sulphide photo cell is a light variable resistor which is most sensitive in the green to yellow portion of the light spectrum. With it you can use light to control many electronic devices. Max. resistance .5 meg., min. resistance 100 ohms, max. voltage 170 V, max. wattage .2 watts, rugged epoxy case.

APPLICATIONS

- Night light
- Light control
- Burglar alarm
- Relay

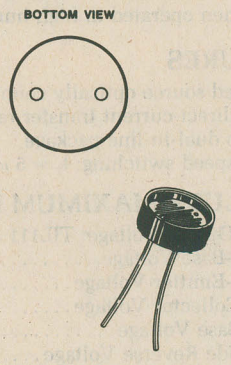
SPECIFICATIONS

- Shape ..... Round
- Sensitive Area ..... .07 sq. in.
- Weight ..... 1.56 gms.
- Resistance at 1 Ftc (2870°K) ..... 1.7k Ohms . 40%
- Typical Resistance 100 Ftc (2870°K) ..... 100 Ohms
- Resistance Dark Minimum (1 Minute) ..... 0.5 Megohms

ABSOLUTE MAXIMUM RATINGS

Max. Applied Voltage (ac or dc) ..... 170 V peak
Max. Power Dissipation at 25°C ..... 2 watts
Power Derating ..... Linearly to 0 @ 75°C
Operating Temp. Range ..... −40°C to 75°C

PIN CONNECTION



$1.79

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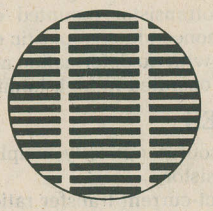
276-123 3" SILICON SOLAR CELL

GENERAL DESCRIPTION

The silicon solar cell is a device that can change light energy into electrical energy for use in your electronic projects. It can be used in place of a battery, or it can be used to charge batteries for a 24 hour solar power supply.

APPLICATIONS

- Solar-powered battery charger
- Use several in series or parallel for added power.
- Power radio circuits



PHOTOELECTRIC CHARACTERISTICS

@ 100mW/cm^{2}or one sun, 25°C ambient temp.

Max Voltage Output 0.45V
Max Current Output 1A

$14.95

276-130 SILICON PHOTOTRANSISTOR

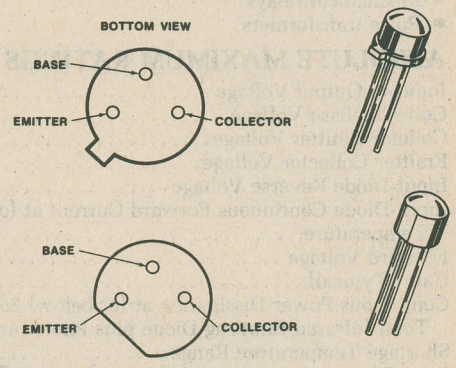
GENERAL DESCRIPTION

The 3 terminal phototransistor has exceptionally stable characteristics and high illumination sensitivity. The electrically connected base lead increases its applicability to various circuit designs. It features low leakage, low power requirements, TTL/DTL compatibility, a wide sensitivity range and fast response.

ABSOLUTE MAXIMUM RATINGS

Maximum Temperature/Humidity
Storage Temperature ..... −55°C to 100°C
Operating Junction Temperature ..... −55°C to 85°C
Relative Humidity at Temperature ..... 98% to 65°C
Maximum Power Dissipation
Total Dissipation at 25°C Case Temperature ..... 200 mW
at 25°C Ambient Temperature ..... 100 mW
Maximum Voltages
V_{CBO} Collector to Base Voltage ..... 50 Volts
V_{CEO} Collector to Emitter Sustaining Voltage ..... 30 Volts
Maximum Current
I_C Collector Current ..... 25 mA

PIN CONNECTION



The base lead is for testing only, it is not used in normal applications.

$1.09

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DIGITAL LED ALARM CLOCK/THERMOMETER MODULE

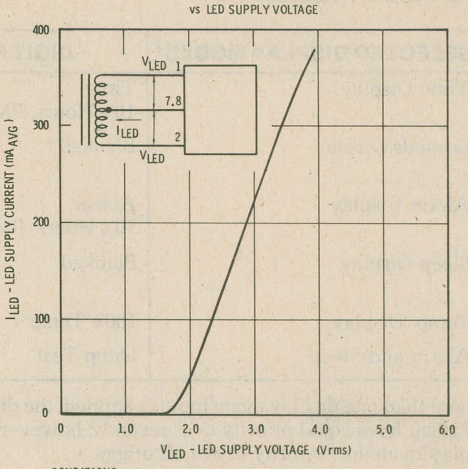
MA1026
277-1006

GENERAL DESCRIPTION

The MA1026 is a complete electronic digital clock/thermometer module featuring a 4-digit LED display. A transformer, setting switches, and temperature sensor are required to produce a low-cost, full featured movement for use in thermometer, alarm clock, clock radio, instrument panel clock and appliance timer applications. Advanced packaging techniques allow minimum overall size and high volume production of finished products.

Key features include temperature display in both °C or °F, multiple 9-minute snooze, "one-finger" sleep setting, easy to use fast and slow setting controls, seconds display, PM, alarm ON, colon and degree indicators and time-set lockout. Several options are available which include components for on-board radio switching and speaker drive of an 800 Hz nominal alarm-tone output gated at a 2 Hz rate. Maximum flexibility is provided by user-programmable 12/24-hour display, 50/60 Hz input and fixed or flashing colon indicator. In addition, the display brightness level can be varied with a potentiometer for continuous control, or an SPST switch for bright/dim modes.

TYPICAL LED SUPPLY CURRENT
vs LED SUPPLY VOLTAGE

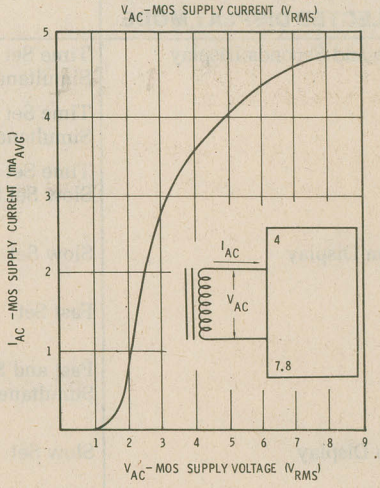


CONDITIONS:
1. LAMP TEST (ALL SEGMENTS DRIVEN)
2. DISPLAY DIM (PIN 6) OPEN - MAXIMUM BRIGHTNESS

FEATURES

- 0.7" – 4-digit LED display available with or without lens in red or clear surface color
- "One-finger" 59-minute sleep counter setting
- Multiple 9-minute snooze counter
- PM, colon, degree and alarm "On" LED indicators
- Entire display flashes to indicate power loss
- Simple fast/slow setting controls
- Time-set lockout feature eliminates accidental timesetting without inhibiting alarm or sleep setting
- 6 display modes (temperature, time, seconds, alarm, sleep and lamp test)
- User selectable °C/°F, 12/24-hour, 50/60 Hz and fixed/flashing colon operation
- Leading zero blanking
- Requires the addition of transformer, setting switches, and sensor
- Low power consumption
- Direct-drive LED display—no RFI
- Bright/dim or continuous display brightness control capability
- 800 Hz (nominal) alarm-tone output, gated at a 2 Hz rate

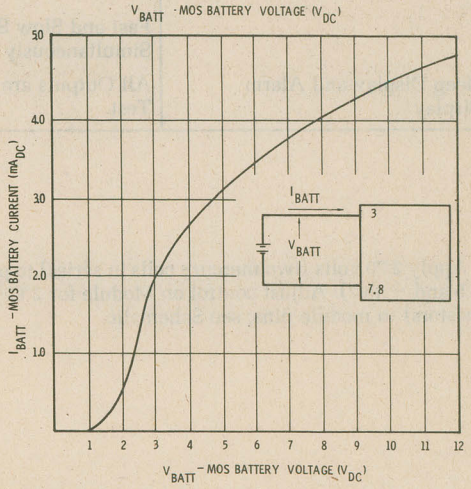
I_{AC}–TYPICAL MOS SUPPLY CURRENT (mA_{AVG}) vs.
V_{AC}–MOS SUPPLY CURRENT (V_{RMS})



APPLICATIONS

- Clock radio timers
- Alarm clocks
- Desk clocks
- TV/stereo timers
- Instrument panel clocks
- Thermometers (°C or °F)

I_{BATT} –TYPICAL MOS BATTERY CURRENT (mA_{DC}) vs.
V_{BATT} –MOS BATTERY VOLTAGE (V_{DC})



ABSOLUTE MAXIMUM RATINGS

Voltage at All Pins Except 1,3 and 32	V_{SS} –0.3V to V_{SS} +12V
Voltage at Pins 1 and 32	V_{SS} –3V to V_{SS} +6V
Voltage at Pin 3	V_{SS} –17V to V_{SS} +17V
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	–20°C to +85°C
Terminal Temperature (Soldering, 5 seconds)	230°C

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MA1026 (277-1006)

DISPLAY MODES

SELECTED DISPLAY MODES*	DIGIT NO. 4	DIGIT NO. 3	DIGIT NO. 2	DIGIT NO. 1
Time Display	Time 10's Hours, PM Ind.	Time Hours	Time 10's Minutes	Time Minutes, Alarm ON Ind.
Seconds Display	Blanked	Time Minutes	Time 10's Seconds	Time Seconds
Alarm Display	Alarm 10's Hours, PM Ind.	Alarm Hours	Alarm 10's Minutes	Alarm Minutes, Alarm ON Ind.
Sleep Display	Blanked	Blanked	Sleep 10's Minutes	Sleep Minutes
Temp. Display	100's Temp.	10's Temp.	1's Temp.	°C or °F
Alarm and Sleep	Lamp Test	Lamp Test	Lamp Test	Lamp Test

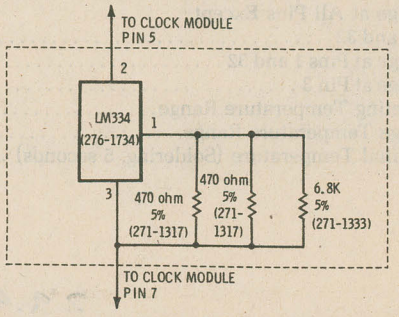
*If more than one display mode input is applied, the display priorities are in the order of temperature, alarm or sleep, seconds, then time. Alarm and sleep have equal priority over seconds; however, when both alarm and sleep are applied, all outputs are ON, providing a lamp test. This display mode has priority above all others.

CONTROL SETTING FUNCTIONS

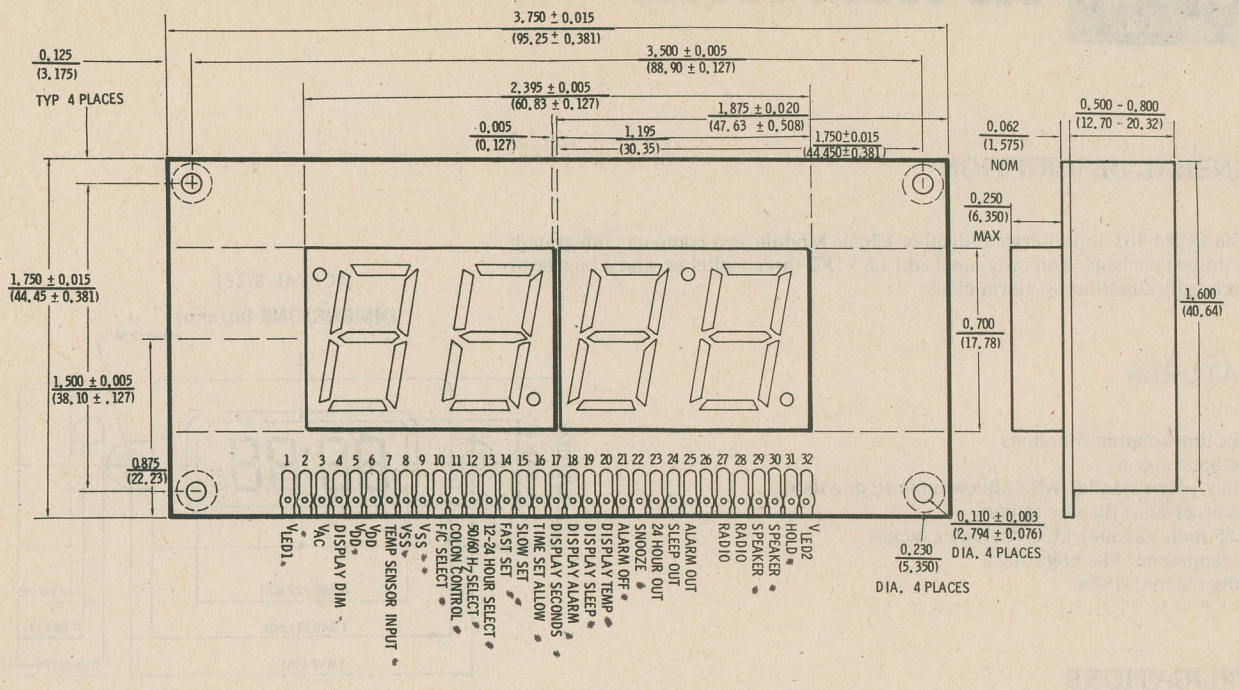
SELECTED DISPLAY MODE	CONTROL INPUT	CONTROL FUNCTION
Time and Seconds Display	Time Set Allow and Slow Set Simultaneously	Minutes advance at a 2 Hz rate and Seconds Counter is reset to :00.
	Time Set Allow and Fast Set Simultaneously	Minutes advance at a 60 Hz rate. Seconds Counter not affected.
	Time Set Allow and Fast and Slow Set Simultaneously	Hours, Minutes, and Seconds are reset to: 12:00:00 AM (12-Hour Mode) 0:00:00 (24-Hour Model).
Alarm Display	Slow Set	Alarm Minutes Counter advances at a 2 Hz rate.
	Fast Set	Alarm Minutes Counter advances at a 60 Hz rate.
	Fast and Slow Set Simultaneously	Alarm Minutes and Hours Counters are reset to: 12:00 AM (12-Hour Mode) 0:00 (24-Hour Model).
Sleep Display	Slow Set	Sleep Counter is decremented at a 2 Hz rate.
	Fast Set	Sleep Counter is decremented at a 10 Hz rate.
	Fast and Slow Set Simultaneously	Sleep Counter is reset to 59 minutes.
Sleep Display and Alarm Display	All Outputs are Driven to Provide a Lamp Test.	

Apply 2.70 volts (two mercury cells in series) to pins 5 and 7 of the Module (+ to 5 and − to 7). Adjust control on Module for 2°C. Connect LM334 sensor (with resistors) to module pins; see Schematic.

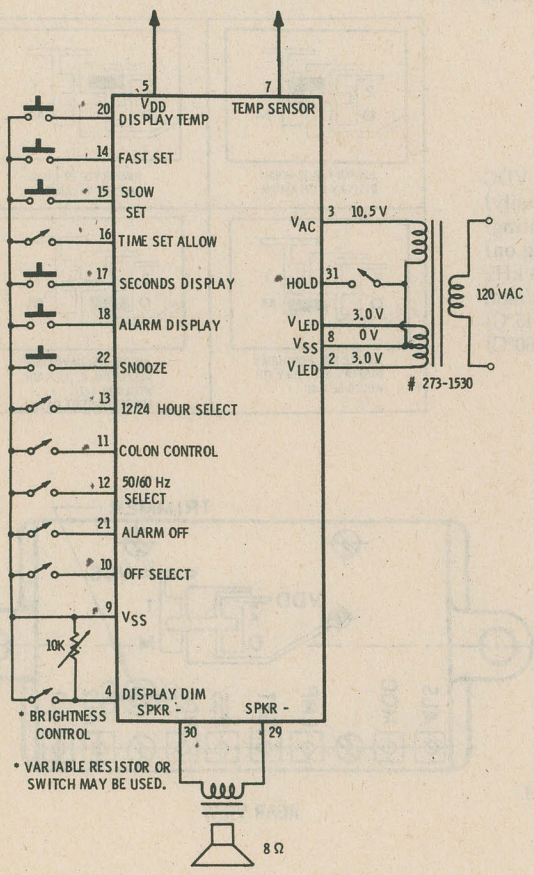
Calibration and Sensor Assembly



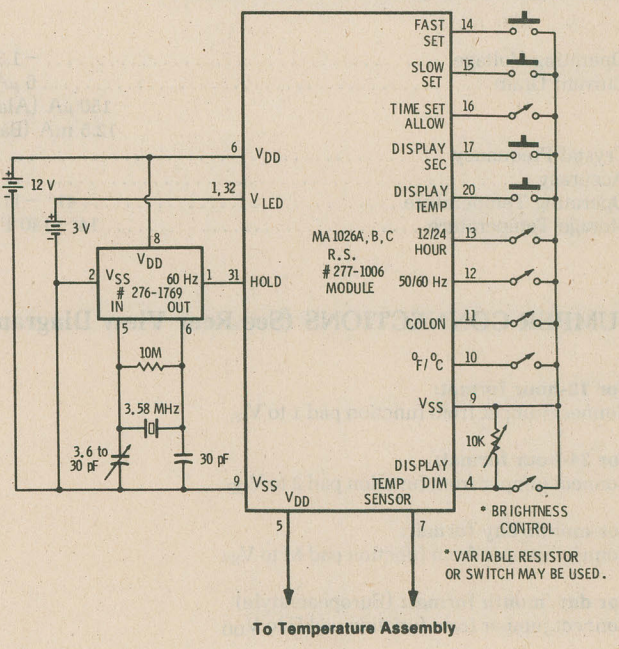
MA1026 (277-1006)



TYPICAL APPLICATIONS



Alarm Clock/Thermometer



Instrument Panel Thermometer

PCIM-161 LCD CLOCK MODULE

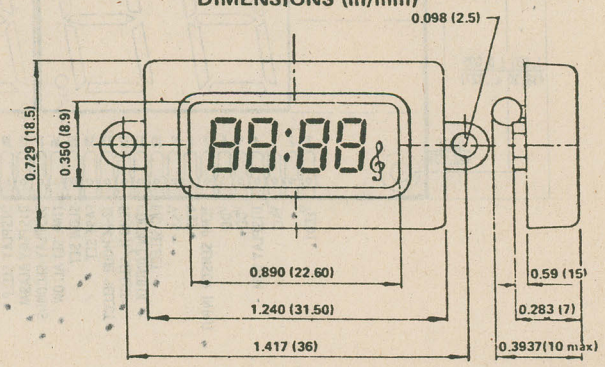
277-1005

GENERAL DESCRIPTION

The PCIM-161 liquid-crystal-display Clock Module is a compact, integrated, easy-to-use package. You only need add 1.5 VDC, three switches, and a buzzer to have a fully functioning alarm clock.

(ACTUAL SIZE)

DIMENSIONS (in/mm)



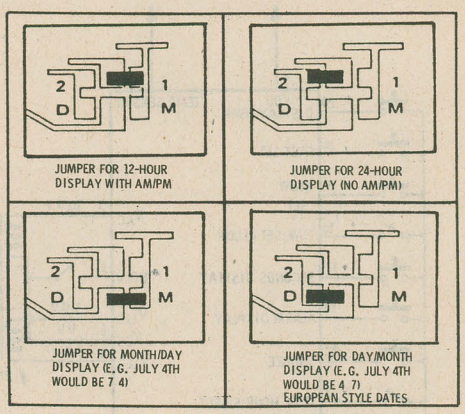
FEATURES

- Six timekeeping functions
- 24-hour alarm
- Four-year calendar with alpha-numeric day/date
- 12 or 24-hour display option
- 0.25-inch (6.4mm) LCD character height
- Incandescent blacklighting
- Low current drain

APPLICATIONS

Compact design allows for easy mounting in any equipment such as pocket clock, radio, cassette, receivers, etc.

Display Jumper Options



ABSOLUTE MAXIMUM RATINGS

Operating Voltage	−1.3 to −1.6 VDC
Current Drain	6 μA (Clock only)
	150 μA (Alarm operating)
	12.5 mA (Backlighting on)
Crystal Frequency	32.768 kHz
Accuracy	±13 sec/mon
Operating Temperature	41° −113°F (5°−45°C)
Storage Temperature	14°−140°F (−10°−60°C)

JUMPER CONNECTIONS (See Rear View Diagram)

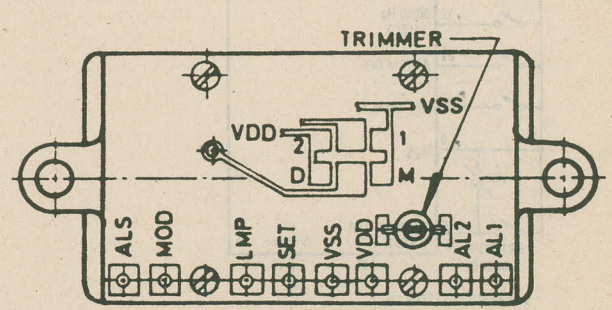
For 12-hour format:
Connect jumper from function pad 1 to V_{SS}

For 24-hour format:
Connect jumper from function pad 2 to V_{DD}

For month/day format:
Connect jumper from function pad M to V_{SS}

For day/month format: (European-style)
Connect jumper from function pad D to V_{DD}

NOTE: In 12-hour time display format, "A" or "P" will indicate AM or PM.



REAR VIEW

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PCIM-161 (277-1005)

SETTING THE CLOCK

Press MOD (Hour digit will flash) Press and hold SET	Hold until the desired hour is displayed. (AM or PM in 12-hour format)
Press MOD (Minute digit will flash) Press and hold SET	Hold until the desired minute is displayed.
Press MOD Press SET	Starts the clock running at the present time.

NOTE: Clock can be set exactly by using a radio or telephone time tone.

SETTING THE CALENDAR AND DAY-OF-THE-WEEK

Press and hold MOD (About three-seconds) Press and hold SET	Month and date will appear on display. Hold until the desired month is displayed.
Press MOD Press and hold SET	Hold until the desired date is displayed.
Press MOD Press and hold SET	Hold until the desired day-of-the-week is displayed.
Press MOD	Returns display to time.

NOTE: The calendar automatically compensates for the number of days in a month (it must be reset during a leap year).

SETTING THE ALARM

Press ALS twice within three-seconds Press and hold SET	Hold until desired alarm hour appears on the display. (AM or PM in 12-hour format)
Press ALS Press and hold SET	Hold until desired alarm minute appears on the display.
Press ALS	Alarm time will be displayed momentarily. Display will then return to actual time. " 🔔 " will illuminate to indicate the alarm is set.

OPERATIONAL NOTES

- During normal operation, time is displayed.
- Momentarily pressing the SET button will cause the date to be displayed for one-second, followed by the day-of-the-week for one-second. The display then returns to time.
- Seconds can be displayed by pressing SET twice within two-seconds. To return the display to time, press SET once again.
- The day-of-the-week display is as follows:

SU MO TU WE TH FR SA

- Pressing LMP will illuminate the display.

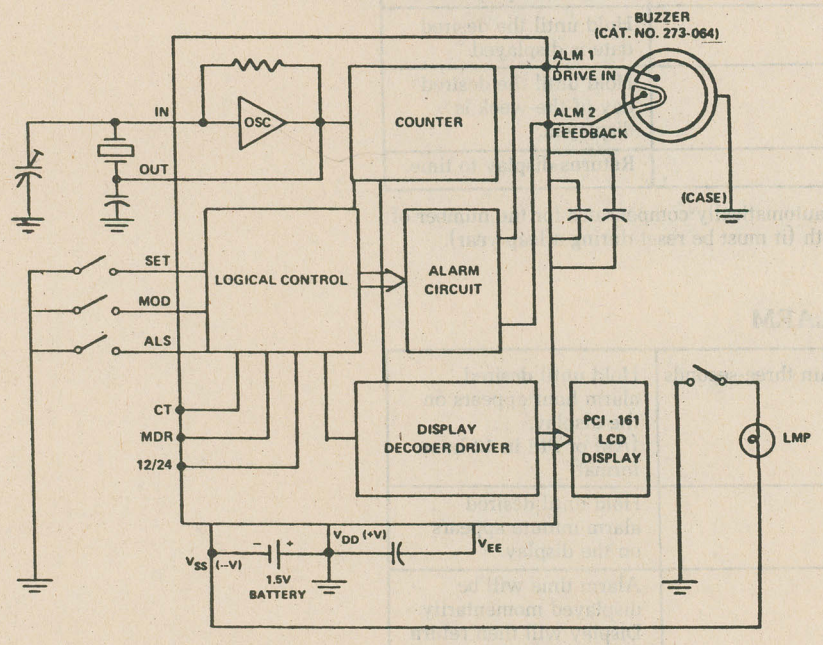
PCIM-161 (277-1005)

ALARM OPERATION

The alarm sounds for 15-seconds at the preset time. "♁" indicates the alarm is set. To set the alarm, press ALS momentarily. ("♁" will illuminate). To turn off the alarm, press and hold ALS until "♁" goes out.

NOTE: The alarm can be cut off before the 15-second interval by pressing SET or ALS. If this is done, the alarm time must be reset. (Refer to Setting the Alarm.)

INTERNAL CIRCUIT



0.5" LCD TIMER/CLOCK MODULE

PCIM 174/175
277-1007

GENERAL DESCRIPTION

The PCIM174/175 is a 0.5" LCD, 12/24 hour clock display. The display modes are normal, second, alarm timer/counter time, dual time, stopwatch and counter. Normal time is displayed when ALS is at V_{SS}. Minutes and seconds are displayed when the SEC is at V_{DD}. Alarm time is displayed when ALS is at V_{DD}. Dual time is displayed when ALS and DUT are at V_{DD} and stopwatch time is displayed when ALS and STW are at V_{DD}.

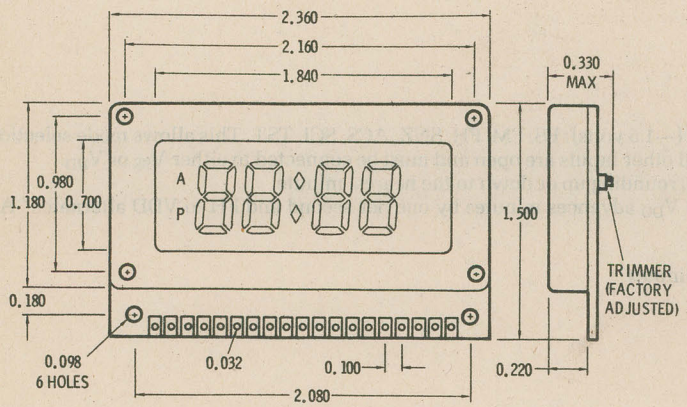
FEATURES

- 12/24 hour user-selectable formate
- 0.5 inch (12.7mm) digit height
- 4 minute snooze time
- Alarm symbol (Δ)
- 24 minute stopwatch
- Dual time
- Hours and minutes can be set independently
- 4 minute alarm output
- Incandescent lamp back lighting
- Sleep and control timer

ABSOLUTE MAXIMUM RATINGS

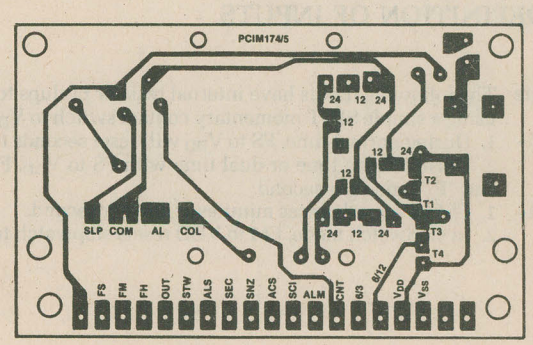
Operating Voltage, Referenced to V_{DD} ..... −3V
Operating Temperature ..... 0 to 50°C
Storage Temperature ..... −10 to 60°C

PIN CONNECTION



FRONT VIEW

12/24 HOUR FORMAT SELECTION



REAR VIEW

For 12 hour format solder all options labeled "12"
For 24 hour format solder all options labeled "24"
NOTE: Pads are arranged so gaps can be bridged with solder.

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PCIM-174/175 (277-1007)

ELECTRICAL CHARACTERISTICS

Supply Voltage, Referenced to V_{DD} 1.9V
Current Consumption 10uA
Alarm/Control/Sleep Output current ..... 100uA(min)
Time Accuracy (f = 32768HZ) ..... 30 Sec/Mon
Lamp Current Drain at V_{SS} = 1.5V 40mA

DISPLAY FORMAT

DISPLAY MODE	12 HOUR FORMAT	24 HOUR FORMAT	CONNECT TO V_{DD}	TO SET CONNECT TO V_{DD}
NORMAL	hrs min P 10:53 Δ	hrs min 22:53 Δ	—	FH FM
SECOND	min sec 3:26 Δ	min sec 3:26 Δ	SEC	FS
ALARM TIME/ COUNTER TIMER	hrs min P 2:30 Δ	hrs min 14:30 Δ	ALS	FH FM
DUAL TIME	hrs min P 3:30	hrs min 14:30	DUT ALS	FH FM
STOPWATCH	min sec 0.00	min sec 0:00	STW ALS	FH FM
COUNTER	count 0:00	count 0:00	STW ALS	FM STW

Δ ALARM ENABLE

Note: Stopwatch in 12 hour format, "A" (AM indicator) comes on at 10 minutes and both "A" and "P" come on at twenty minutes elapsed time. Total elapsed time indicated is 24 minutes. Stopwatch resets to zero and continues counting after this period.

DESIGNATION AND DEFINITION OF INPUTS

Note: The following inputs have internal resistor pullups to V_{SS} (—1.5 volts): FS, FM, FH, SNZ, ACS, SCI, TST. This allows mode selection using a simple SPST momentary contact switch to V_{DD}. All other inputs are open and must be connected to either V_{SS} or V_{DD}.

FS—
1. During normal time, FS to V_{DD} will reset seconds to '00', rounding up or down to the nearest minute.
2. During alarm time or dual time with FS to V_{DD}, FM to V_{DD} advances minutes by one per second and FH to VDD alternates "A" and "P" at one per second.

FM—
1. FM to V_{DD} advances minutes at one per second.
2. In stopwatch mode, FM to VDD resets stopwatch to 0 minutes.

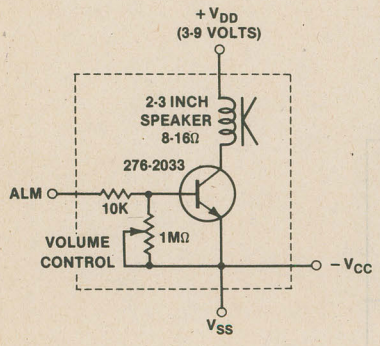
PCIM-174/175 (277-1007)

FH— 1. FH to VDD advances hours at one per second.
2. In stopwatch mode, FH to VDD starts/stops stopwatch.
DUT— Dual time is displayed when DUT and ALS are both at V_{DD}.
STW— Stopwatch is displayed when STW and ALS are both at V_{DD}.
ALS— 1. ALS to V_{SS}, normal time is displayed.
2. ALS to V_{DD}, alarm time is displayed.
3. Both ALS and DUT to V_{DD}, dual time is displayed.
4. Both ALS and STW to V_{DD}, stopwatch is displayed.
SEC— SEC to V_{DD}, minutes and seconds are displayed.
SNZ— 1. SNZ to V_{DD} will stop the alarm output for 3 to 4 minutes.
SNZ to V_{DD} also resets sleep and control time. See waveform 3.
ACS— ACS to V_{DD} immediately cancels alarm, control and sleep outputs.
6/3 and 6/12
Selects the duration of the sleep and control outputs as follows: Select and solder PCB jumpers or use 6/3, 6/12 inputs with external switches (see rear view).

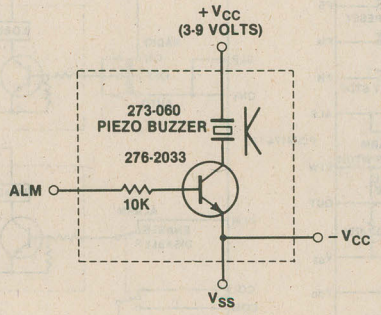
15 minutes connect T2 and T4
30 minutes connect T2 and T3
60 minutes connect T1 and T3
120 minutes connect T1 and T4

V_{DD}— Positive input for 1.5 volt supply
V_{SS}— Negative input for 1.5 volt supply
LMP— Two inputs for backlight lamp (1.5 volts—intermittant operation only)
AL— Input to alarm enable symbol (Δ). Enabled when connected to COL (Colon), off when connected to COM.

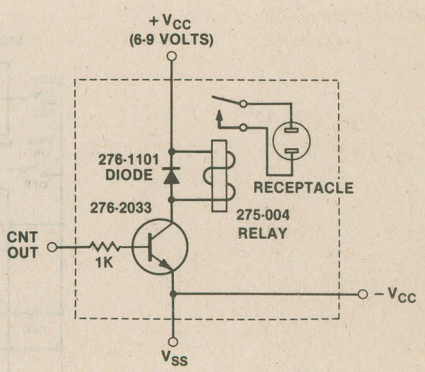
LOAD OPTIONS



Alarm Circuit For Speaker



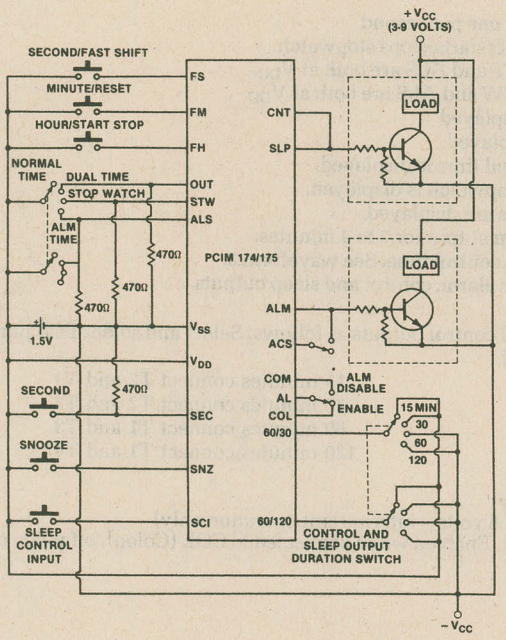
Alarm Circuit for Piezo Buzzer



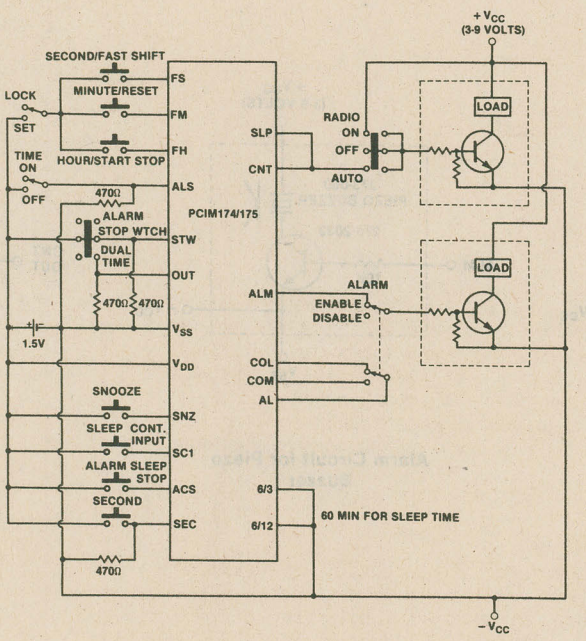
Control Output Circuit for Relay

PCIM 174/175 (277-1007)

TYPICAL APPLICATIONS



Alarm Clock with Sleep, Snooze, Stopwatch, Dual Time and Control Unit.



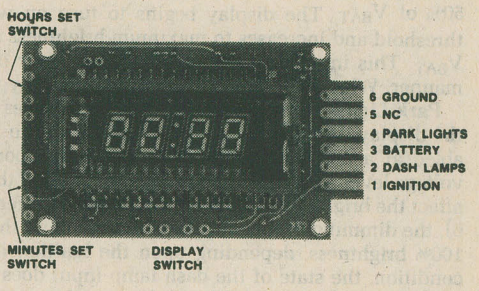
Radio/Alarm Clock with Sleep, Snooze, Stopwatch and Dual Time.

12 VDC AUTOMOTIVE/INSTRUMENT CLOCK MODULE 277-1003

GENERAL DESCRIPTION

The MA-1003 12VDC Automotive/Instrument Clock Module combines the MM5377 monolithic MOS/LSI clock circuit, a 4-digit 0.3" green vacuum fluorescent display, a 2.097 MHz crystal and supporting components to form a complete digital clock for 12VDC applications. The module is fully protected against automotive transients and battery reversal conditions with time-keeping maintained down to 9VDC Automatic display brightness control logic blanks the display with ignition off, reduces brightness to 33% with park or head lamps on and follows the dash lamp dimming control setting. The display features leading zero blanking and has a blinking colon activity indicator. The bright green display color is filterable to various shades in the green, blue-green, blue and yellow color range. Time setting is accomplished by closing hours-advance and minutes-advance switches; these switches are disabled when the display is blanked to prevent tampering. Interconnections are simplified through use of a 6-pin edge connector. Display may be activated with ignition off or park (head) lights off by closing display switch, allowing minimum power consumption in portable applications.

PIN CONNECTION

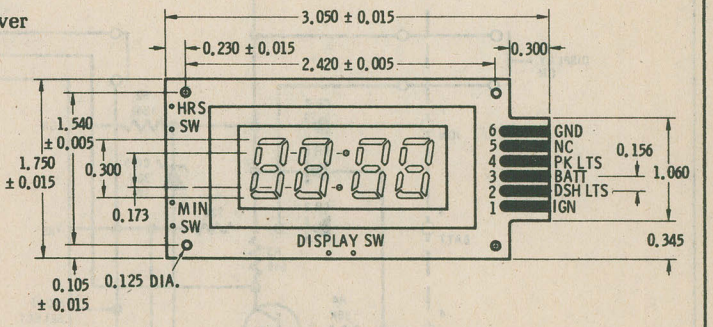


FEATURES

- Ideal for automotive applications
- Operates from 12VDC supply
- Bright 0.3" green display
- Internal crystal timebase
- ±0.5 second/day accuracy
- Protected against automotive voltage transients and reversals
- Timekeeping maintained to 9VDC memory to 6 VDC
- Automatic display brightness control logic
- Display color filterable to blue, blue-green, green and yellow
- Complete—just add switches and lens
- Convenient time setting controls at a 1 Hz rate with no roll-over
- Compact size, built-in connector (optional)
- Low standby power consumption
- Lockout of time setting when display is "OFF"

APPLICATIONS

- In-dash autoclocks
- After-market auto/recreational vehicle clocks
- Aircraft-marine clocks
- 12VDC operated instruments
- Portable/battery powered instruments



FUNCTIONAL DESCRIPTION

DISPLAY FUNCTIONS

Brightness Control: The 277-1003 provides four basic selectable display brightness modes. These are summarized in table I. Note that 33% and 0% brightnesses are boundary values only. Any brightness in between is obtainable by simply varying the dash lamp input (pin 2) voltage between V_{BAT} (pin 3) and GND (pin 6). Note the difference between "display blanked" and "0% brightness."

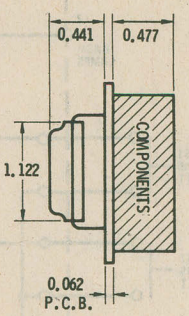
Colon: The 277-1003 is furnished with a colon display which flashes at a 0.5 Hz rate (one second "ON," one second "OFF"). When setting minutes, the colon blinks at a 1 Hz rate.

Zero Blanking: Zeros appearing in the first (tens hours) digit are blanked automatically.

CONTROL FUNCTIONS

Control Inputs: Inputs including battery, ignition, park lights, dash lamps and a respective ground are routed to the edge connector tab for easy connection/disconnection. The remaining inputs including hours set, minutes set and display "ON" are available at terminals near the edge of the PC board for facilitating "on board" switch contacts or external switches (user supplied). See Pin Connection diagram.

Battery Input (Pin 3): This input powers the MOS clock circuit only and insures timekeeping above 9VDC The input is protected against battery reversals, excessive current and transient overvoltages.



Side View for Mounting Clearance

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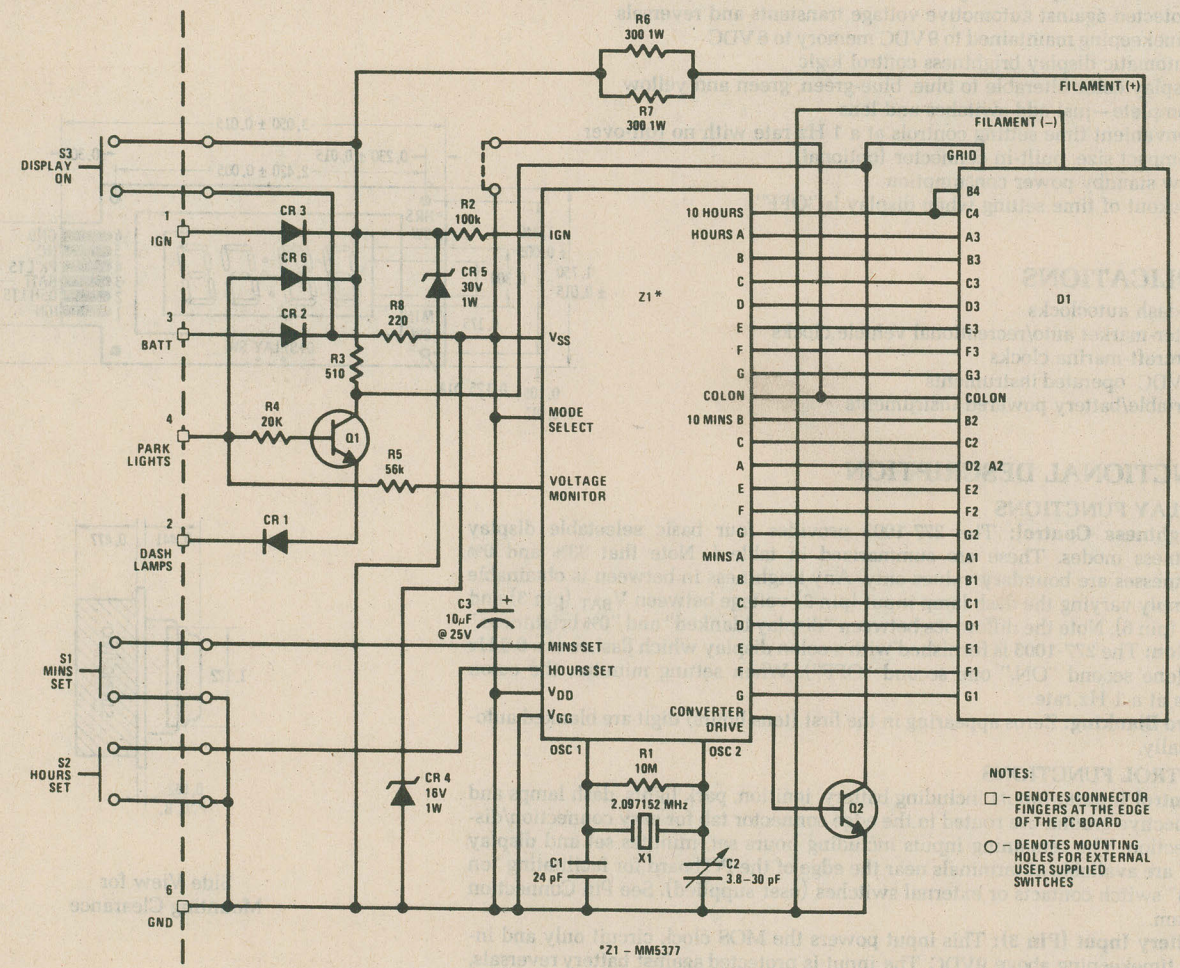
277-1003

Ignition Input (Pin 1): This input enables setting of the clock using the hours and minutes set inputs, enables the display to display time of day information and enables the display to be dimmed by the use of the park and dash inputs. Again, this input is similarly protected. When this input is at a voltage equal to V_{BAT} (pin 3), the time set, display and dimming are enabled. When the input is at GND (pin 6), the time set, display and dimming are disabled. Nominal voltage levels on this input are V_{BAT} and GND; however, the actual threshold is approximately 50% of V_{BAT}. The display begins to turn on with minimal brightness at this threshold and increases to maximum brightness as the input voltage approaches V_{BAT}. This input does not affect the accuracy of the timekeeping logic in any manner. When left open, the input is internally pulled to GND (see table I).

Park Lights Input (Pin 4): This input enables the display and the dimming of the display. If the input is at a voltage equal to V_{BAT} (pin 3), the display is enabled at a brightness of 0.33%, depending upon the dash lamp input (pin 2) voltage level. During this condition, the state of the ignition input (pin 1) does not affect the brightness of the display in any manner. When the input is at GND (pin 6), the dimming of this display is disabled and the display is either blanked or at 100% brightness, depending upon the ignition input voltage level. During this condition, the state of the dash lamp input does not affect the brightness of the display in any manner. When left open, the state of the input is dependent upon the state of the ignition input. When ignition is high (V_{BAT}), park is internally pulled high; when ignition is low (GND), park is internally pulled low. See table I. Nominal voltage levels on this input are V_{BAT} or GND. However, the actual threshold is approximately 50% of V_{BAT}. This input is also protected against transients and reversals.

INTERNAL CIRCUIT



277-1003

Dash Lamps Input (Pin 2): This input controls the display brightness only when the park lights input (pin 4) is active (V_{BAT}). When this input is high, or at V_{BAT}, the relative brightness of the display is 33%. When this input is low, or at GND, the relative brightness is 0%. As the input voltage is varied from GND to V_{BAT}, the brightness varies linearly from 0% to 33%. When the park lights input is not applied, or low, this input does not affect the display brightness in any manner. When left unconnected, the input is internally pulled high (see table I). Like all other edge connector control inputs, this input is similarly protected.

Hours and Minutes Set Inputs: These inputs are used to reset time. Hours set will advance the hours at a 1 Hz rate when the input is held at GND. While setting hours, the minutes counter may also advance the hours count. Minutes set will advance the minutes at a 1 Hz rate, hold the internal seconds counter reset to 00 and cause the colon to blink at a 1 Hz rate when the input is held at GND. When left unconnected, both inputs are internally pulled high, or to V_{BAT}. Unlike the edge connector control inputs, these inputs are unprotected, and normal precautions taken for handling of MOS devices should be applied to the handling of this module. Both inputs include two PC board terminals located near the edge of the module which can accept SPST switches (see Pin Connection diagram).

Display "ON" Switch Input: This input provides a means for displaying time at 100% brightness when both the ignition and park lights inputs (pins 1 and 4) are low or at GND. The input includes two PC board terminals located near the edge of the module which can accept an SPST switch (see Pin Connection diagram).

ELECTRICAL CHARACTERISTICS T_A = 25°C, V_{BAT} = 14 V_{DC}, display at 10:08 unless otherwise specified.

Power Supply Voltage (V_{BAT})	Timekeeping Maintained	9 thru 14	V_{DC}
	Time Memory Maintained	6 thru 14	V_{DC}
Power Supply Current (I_{BAT})	Display Blanked*	2	mA
	100% Brightness*	83	mA
	33% Brightness*	97	mA
	0% Brightness*	104	mA
Power Consumption	Display Blanked*	25	mW
	100% Brightness*	1.2	W
	33% Brightness*	1.4	W
	0% Brightness*	1.5	W
Timing Accuracy	T_A = 25°C	±0.5	Sec/Day
	T_A = −25°C to +65°C	±2	Sec/Day

*See table 1 for corresponding pin connections (pins 1, 2 and 4).

ABSOLUTE MAXIMUM RATINGS

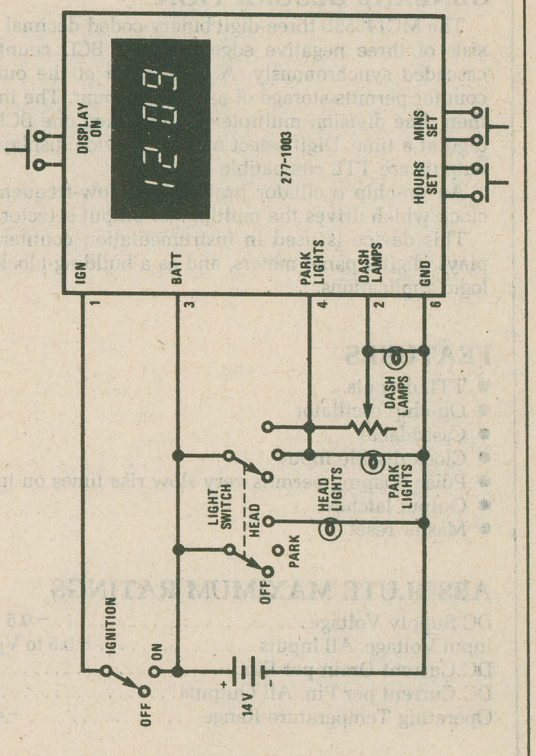
Voltage—Pins 1, 2, 3, 4 to 6 ..... −24V_{DC} to +24V_{DC} (Continuous)
40 V_P, Duration 50 ms
80V_P, Duration 5 ms
−200 V_P, Duration 1 ms
Operating Temperature ..... −40°C to +85°C
Storage Temperature ..... −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

TABLE I: DISPLAY BRIGHTNESS TRUTH TABLE

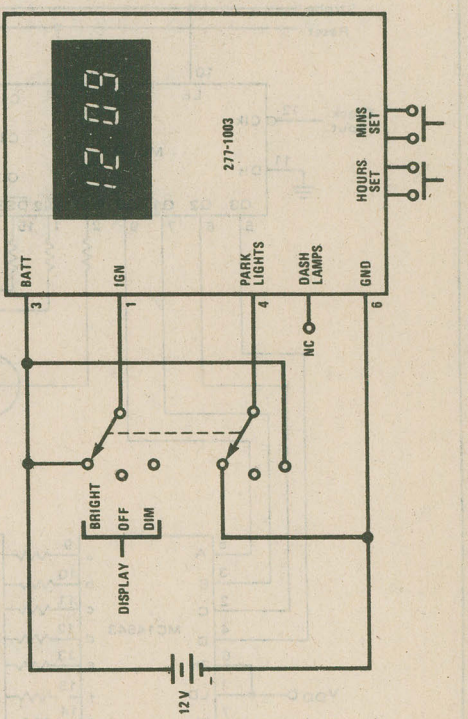
DISPLAY BRIGHTNESS	INPUT PIN CONNECTIONS		
	IGN (Pin 1)	PARK (Pin 4)	DASH (Pin 2)
Display Blanked	L or Open*	L or Open*	X
100% Brightness	H	L	X
33% Brightness	X	H	H or Open*
0% Brightness	X	H	L

* —User may leave this particular input pin unconnected to achieve the same effect as logic level shown.
X—Don't care condition.
H—Connection to BATT input (pin 3).
L —Connection to GND input (pin 6).

TYPICAL APPLICATIONS



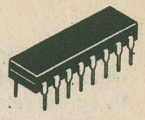
Automotive Application



Battery Powered Instrument Application

MC14553 THREE-DIGIT BCD COUNTER

276-2498



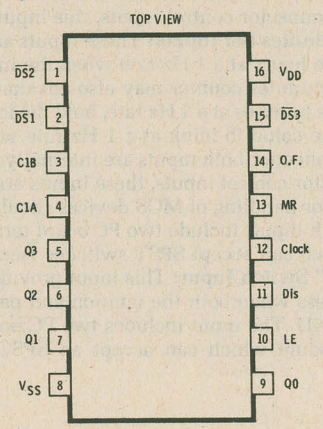
GENERAL DESCRIPTION

The MC14553B three-digit binary-coded-decimal counter consists of three negative edge triggered BCD counters that are cascaded synchronously. A quad latch at the output of each counter permits storage of any given count. The information is then time division multiplexed, providing one BCD number or digit at a time. Digit select outputs provide display control. All outputs are TTL compatible.

An on-chip oscillator provides the low-frequency scanning clock which drives the multiplexer output selector.

This device is used in instrumentation counters, clock displays, digital panel meters, and as a building block for general logic applications.

PIN CONNECTION



FEATURES

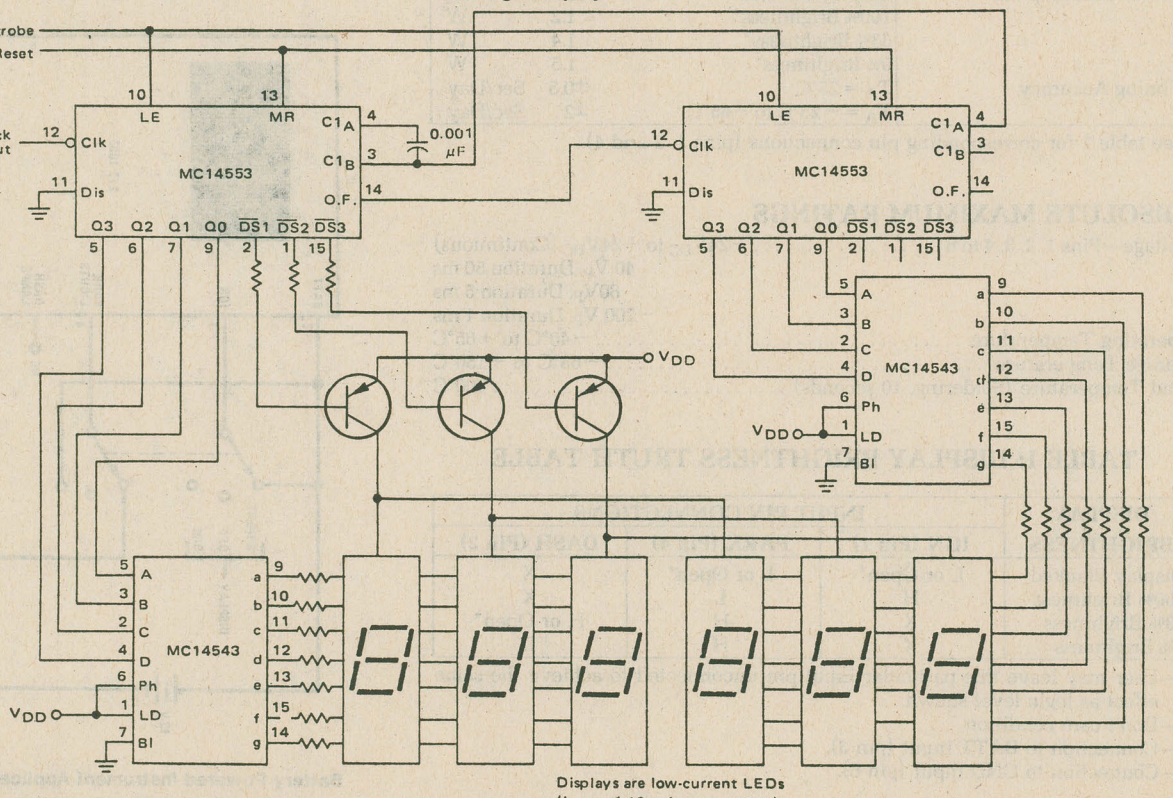
- TTL outputs
- On-chip oscillator
- Cascadable
- Clock disable input
- Pulse Shaping permits very slow rise times on input clock
- Output latches
- Master reset

ABSOLUTE MAXIMUM RATINGS

DC Supply Voltage ..... −0.5 to +18 Vdc
Input Voltage. All Inputs ..... −0.5 to V_{DD} +0.5 Vdc
DC Current Drain per Pin ..... 10 mAdc
DC Current per Pin, All Outputs ..... 20 mAdc
Operating Temperature Range ..... −40 to +85°C

TYPICAL APPLICATION

Six-Digit Display



Displays are low-current LEDs (I_{peak} < 10 mA per segment).

$4.59
p. 126

17-STAGE PROGRAMMABLE OSCILLATOR/DIVIDER

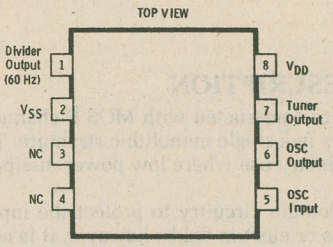
MM5369
276-1769

GENERAL DESCRIPTION

The MM5369 is a CMOS integrated circuit with 17 binary divider stages that can be used to generate a precise 60 Hz reference from commonly available high frequency quartz crystals. An internal pulse is generated by mask programming the combinations of stages 1 through 4, 16 and 17 to set or reset the individual stages. The programmable number the circuit will divide by is masked to 59,659. The MM5369 is advanced one count on the positive transition of each clock pulse.

Two buffered outputs are available: the crystal frequency for tuning purposes and the 17th stage 60 Hz output.

PIN CONNECTION



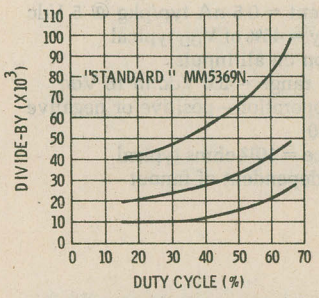
FEATURES

- Crystal oscillator
- High speed (4 MHz at $V_{DD} = 10$)
- Wide supply range 3—15V
- Low power
- Fully static operation
- 8 lead dual-in-line package
- Low current

ABSOLUTE MAXIMUM RATINGS

Voltage at Any Pin ..... $-0.3V$ to $V_{CC} + 0.3V$
Operating Temperature ..... 0°C to +70°C
Package Dissipation ..... 500 mW
Maximum V_{CC} Voltage 16V
Operating V_{CC} Range ..... 3V to 15V
Lead Temperature (Soldering, 10 seconds) ..... 300°C

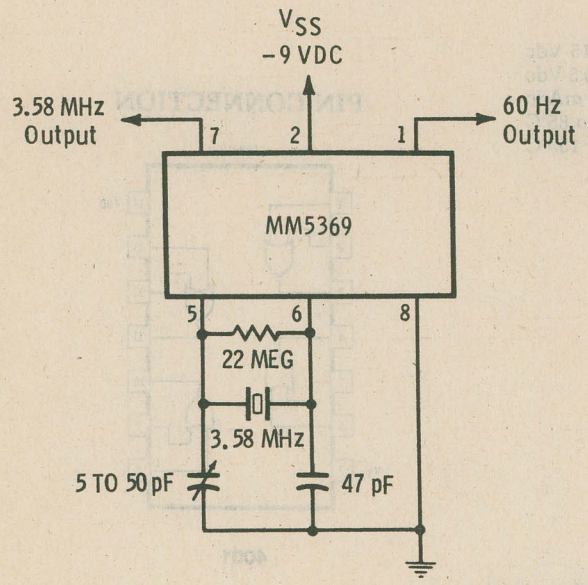
TYPICAL CHARACTERISTICS

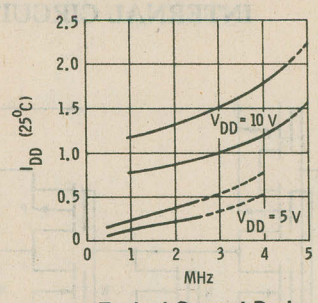


Plot of Divide-By Vs Duty Cycle

TYPICAL APPLICATION

Crystal Oscillator Circuit





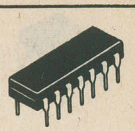
Typical Current Drain Vs Oscillator Frequency

$3.79 cristal $2.59

P.126

4001
276-2401
4011
276-2411

QUAD TWO-INPUT NOR GATE
QUAD TWO-INPUT NAND GATE



GENERAL DESCRIPTION

These devices are constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. These complementary MOS logic gates find primary use where low power dissipation and/or high noise immunity is desired.

These devices contain circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g. either V_{SS} or V_{DD}).

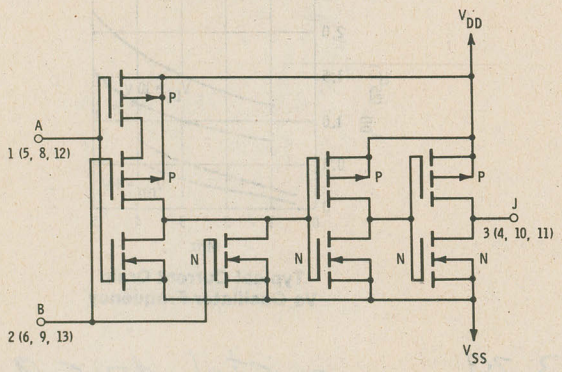
FEATURES

- Quiescent current = 0.5 nA typ/pkg @ 5 Vdc
- Noise immunity = 45% of V_{DD} typical
- Diode protection on all inputs
- Supply voltage range = 3.0 Vdc to 16 Vdc
- Single supply operation—positive or negative
- High fanout >50
- Input impedance = 10^{12} ohms typical
- Logic swing independent of fanout

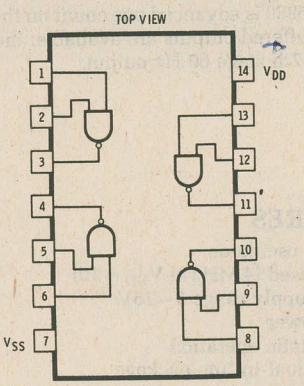
ABSOLUTE MAXIMUM RATINGS
(Voltages referenced to V_{SS})

DC Supply Voltage	−0.5 to +15 Vdc
Input Voltage, All Inputs	−0.5 to V_{DD} +0.5 Vdc
DC Current Drain per Pin	10 mAdc
Operating Temperature Range	−40 to 85°C
Storage Temperature Range	−65 to +150°C

INTERNAL CIRCUIT

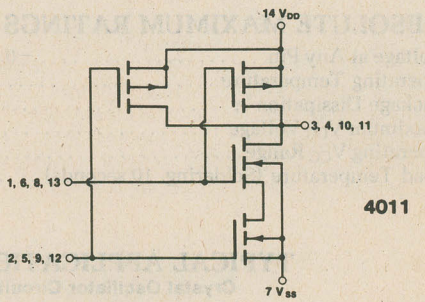


PIN CONNECTION



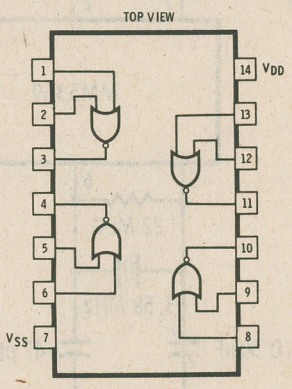
4011

INTERNAL CIRCUIT



4011

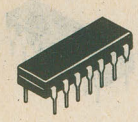
PIN CONNECTION



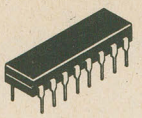
4001

$129

P.126



4013



4027

DUAL TYPE D FLIP-FLOP

DUAL J-K FLIP-FLOP

4013 276-2413

4027 276-2427

GENERAL DESCRIPTION

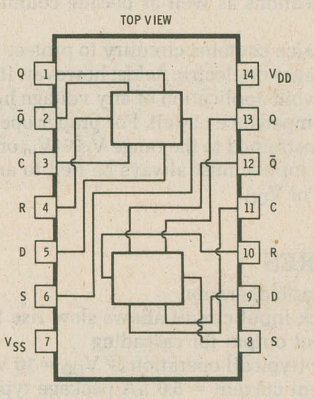
The 4013 dual type D flip-flop is constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. Each flip-flop has independent Data, (D), Direct Set, (S), Direct Reset, (R), and Clock (C) inputs and complementary outputs (Q and $\overline{Q}$). These devices may be used as shift register elements or as type T flip-flops for counter and toggle applications.

These devices contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}.

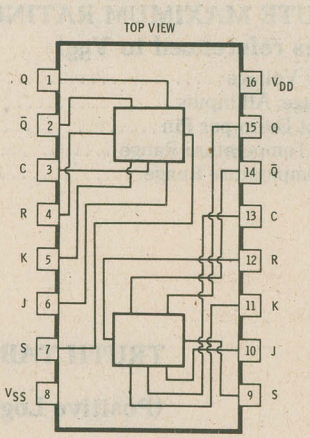
The 4027 dual J-K flip-flop has independent J, K, Clock (C), Set (S) and Reset (R) inputs for each flip-flop. These devices may be used in control, register, or toggle functions.

PIN CONNECTION



4013

PIN CONNECTION



4027

FEATURES

- Static operation
- Quiescent current = 2.0 nA/package typical @ 5 Vdc
- Noise immunity = 45% of V_{DD} typical
- Diode protection on all inputs
- Supply voltage range = 3.0 Vdc to 16 Vdc
- Single supply operation
- Toggle rate = 4 MHz typical @ 5 Vdc
- Logic edge-clocked flip-flop design—logic state is retained indefinitely with clock level either high or low; information is transferred to the output only on the positive-going edge of the clock pulse
- Capable of driving two low-power TTL loads, one low-power schottky TTL load or two HTL loads over the rated temperature range
- Toggle rate = 3.0 MHz typical @ 5 Vdc (4027)

ABSOLUTE MAXIMUM RATINGS
(Voltages referenced to V_{SS})

DC Supply Voltage ..... −0.5 to +16 Vdc
Input Voltage, All Inputs ..... −0.5 to V_{DD} +0.5 Vdc
DC Current Drain per Pin ..... 10 mAdc
Operating Temperature Range ..... −40 to +85°C
Storage Temperature Range ..... −65 to +150°C

TRUTH TABLE

INPUTS					OUTPUTS*		
C†	J	K	S	R	Qn‡	Qn +1	$\overline{Q}$n +1
—	H	X	L	L	L	H	L
—	X	L	L	L	H	H	L
—	L	X	L	L	L	L	H
—	X	H	L	L	H	L	H
—	X	X	L	L	X	No Change	
X	X	X	H	L	X	H	L
X	X	X	L	H	X	L	H
X	X	X	H	H	X	H	H

X = Don't Care
L = Low Level
H = High Level
† = Level Change
‡ = Present State
* = Next State

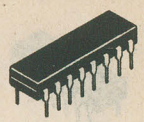
TRUTH TABLE

INPUTS				OUTPUTS	
Clock†	Data	Reset	Set	Q	$\overline{Q}$
—	L	L	L	L	H
—	H	L	L	H	L
—	X	L	L	No Change	
X	X	H	L	L	H
X	X	L	H	H	L
X	X	H	H	H	H

X = Don't Care
L = Low Level
H = High Level
† = Level Change

4017
276-2417

DECADE COUNTER/DIVIDER



GENERAL DESCRIPTION

The 4017 is a five-stage Johnson decade counter with built-in code converter. High-speed operation and spike-free outputs are obtained by use of a Johnson decade counter design. The ten decoded outputs are normally low, and go high only at their appropriate decimal time period. The output changes occur on the positive-going edge of the clock pulse. This part can be used in frequency division applications as well as decade counter or decimal decode display applications.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}.

FEATURES

- Fully static operation
- DC clock input circuit allows slow rise times
- Carry out output for cascading
- 12 MHz (typical) operation @ $V_{DD} = 10$ Vdc
- Quiescent current = 5.0 nA/package typical @ 5 Vdc
- Supply voltage range = 3.0 Vdc to 16 Vdc
- Capable of driving two low-power TTL loads, one low-power Schottky TTL load or two HTL loads over the rated temperature range

ABSOLUTE MAXIMUM RATINGS
(Voltages referenced to V_{SS})

DC Supply Voltage ..... −0.5 to +16 Vdc
Input Voltage, All Inputs ..... −0.5 to V_{DD} +0.5 Vdc
DC Current Drain per Pin ..... 10 mAdc
Operating Temperature Range ..... −40 to +85°C
Storage Temperature Range ..... −65 to +150°C

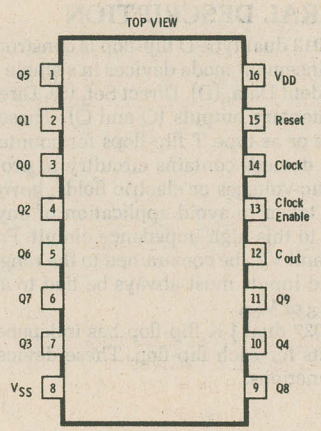
TRUTH TABLE

(Positive Logic)

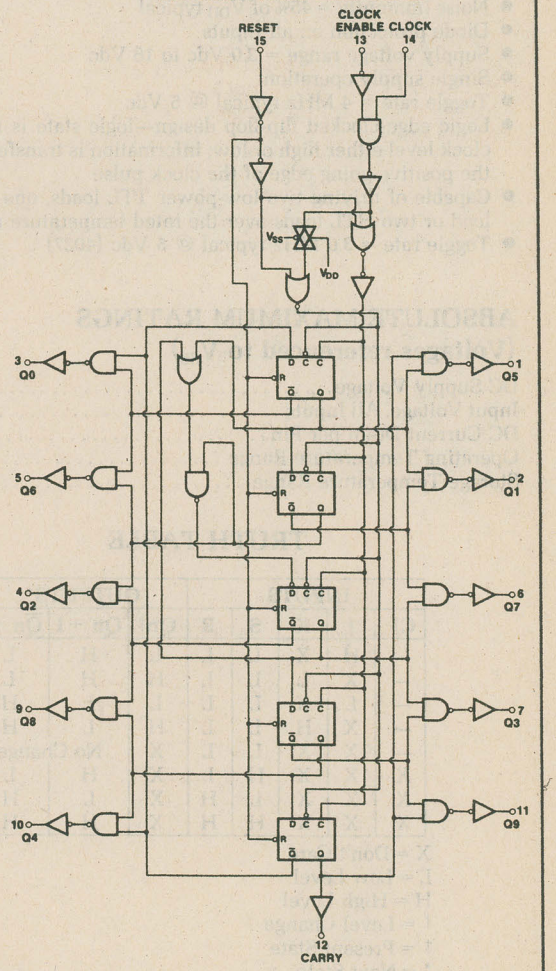
Clock	Clock Enable	Reset	Decode Output = n
L	X	L	n
X	H	L	n
X	X	H	QL
⎍	L	L	n + 1
⎍	X	L	n
X	⎍	L	n
1	⎍	L	n + 1

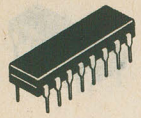
X = Don't Care If n <5 Carry = "H",
Otherwise = "L"
L = Low Level
H = High Level

PIN CONNECTION



INTERNAL CIRCUIT





INVERTING HEX BUFFER
NONINVERTING HEX BUFFER

4049 276-2449
4050 276-2450

GENERAL DESCRIPTION

The 4049 hex inverter/buffer and 4050 noninverting hex buffer are constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. These complementary MOS devices find primary use where low power dissipation and/or high noise immunity is desired. These devices provide logic-level conversion using only one supply voltage, V_{CC}. The input-signal high level (V_{IH}) can exceed the V_{CC} supply voltage for logic-level conversions. Two TTL/DTL Loads can be driven when the devices are used as CMOS-to-TTL/DTL converters (V_{CC} = 5.0 V, $V_{OL} \leq$ 0.4 V, $I_{OL} \geq$ 3.2 mA). Note that pin 16 is not connected internally on these devices; consequently connections to this terminal will not affect circuit operation.

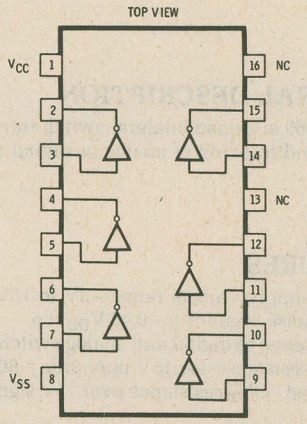
FEATURES

- High source and sink currents
- High-to-low level converter
- Quiescent current = 2.0 nA/package typical @ 5 Vdc
- Supply voltage range = 3.0 Vdc to 16 Vdc

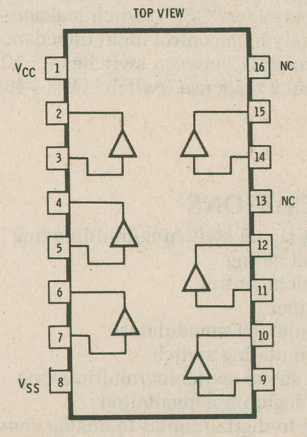
ABSOLUTE MAXIMUM RATINGS
(Voltages referenced to V_{SS}, Pin 8)

DC Supply Voltage	−0.5 to +16 Vdc
Input Voltage, All Inputs	−0.5 to V_{DD} +0.5 Vdc
DC Current Drain per Input Pin	10 mAdc
DC Current Drain per Output Pin	45 mAdc
Operating Temperature Range	−40 to +85°C
Storage Temperature Range	−65 to +150°C

PIN CONNECTION

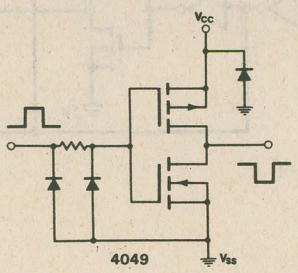


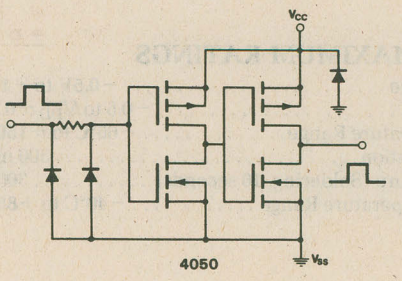
4049



4050

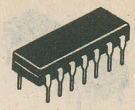
INTERNAL CIRCUIT
(1/6 OF CIRCUIT SHOWN)





4066
276-2466

QUAD BILATERAL SWITCH



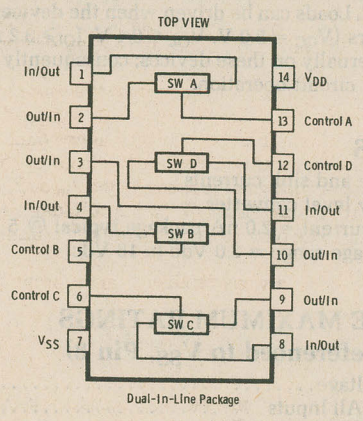
GENERAL DESCRIPTION

The 4066 is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals.

FEATURES

- Wide supply voltage range—3V to 15V
- High noise immunity—0.45 V_{DD} typ
- Wide range of digital and analog switching—± 7.5 V_{PEAK}
- "ON" resistance for 15V operation—80Ω typ
- Matched "ON" resistance over 15V signal input—$\Delta R_{ON} = 5\Omega$ typ
- "ON" resistance flat over peak-to-peak signal range
- High "ON"/"OFF" output voltage ratio—65 dB typ
- High degree of linearity—<0.4% distortion typ
- Extremely low "OFF" switch leakage—0.1 nA typ
- Extremely high control input impedance—$10^{12}\Omega$ typ
- Low crosstalk between switches—−50 dB typ
- Frequency response, switch "ON"—40 MHz typ

PIN CONNECTION

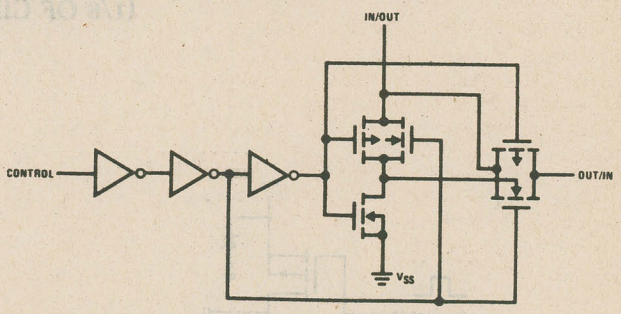


Dual-In-Line Package

APPLICATIONS

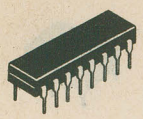
- Analog signal switching/multiplexing
  - Signal gating
  - Squelch control
  - Chopper
  - Modulator/Demodulator
  - Commutating switch
- Digital signal switching/multiplexing
- CMOS logic implementation
- Analog-to-digital/digital-to-analog conversion
- Digital control of frequency, impedance, phase, and analog-signal gain

INTERNAL CIRCUIT



ABSOLUTE MAXIMUM RATINGS

V_{DD} Supply Voltage ..... −0.5V to +18V
V_{IN} Input Voltage ..... −0.5 to V_{DD} +0.5V
T_S Storage Temperature Range ..... −65°C to +150°C
P_D Package Dissipation ..... 500 mW
T_L Lead Temperature (Soldering, 10 seconds) ..... 300°C
T_A Operating Temperature Range ..... −40°C to +85°C



BCD-TO-SEVEN SEGMENT LATCH/DECODER/DRIVER

4511
276-2447

GENERAL DESCRIPTION

The 4511 binary-coded-decimal-to-seven segment latch/decoder/driver is constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and an output drive capability. Lamp test (LT), blanking (BI), and latch enable (LE) inputs are used to test the display, and to store a BCD code, respectively. It can be used with seven-segment light emitting diodes (LED), incandescent, fluorescent, gas discharge, or liquid crystal readouts either directly or indirectly.

Applications include instrument (e.g., counter, DVM, etc.) display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. A destructive high current mode may occur if V_{in} and V_{out} is not constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$

Due to the sourcing capability of this circuit, damage can occur to the device if V_{DD} if applied, and the outputs are shorted to V_{SS} and are at a logical 1 (See Maximum Ratings).

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

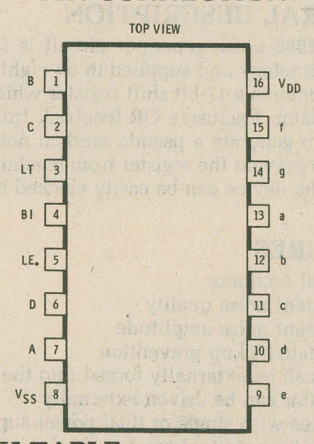
FEATURES

- Quiescent current = 5.0 nA/package typical @ 5 Vdc
- Low logic circuit power dissipation
- High-current sourcing outputs (up to 25 mA)
- Latch storage of code
- Blanking input
- Lamp test provision
- Readout blanking on all illegal input combinations
- Lamp intensity modulation capability
- Time share (multiplexing) facility
- Supply voltage range = 3.0 Vdc to 16 Vdc
- Capable of driving two low-power TTL loads, one low-power Schottky TTL load or two HTL loads over the rated temperature range

ABSOLUTE MAXIMUM RATINGS
(Voltages referenced to V_{SS})

DC Supply Voltage ..... −0.5 to +16 Vdc
Input Voltage, All Inputs ..... −0.5 to V_{DD} +0.5 Vdc
DC Current Drain per Input Pin ..... 10 mAdc
Operating Temperature Range ..... −40 to +85°C
Storage Temperature Range ..... −65 to +150
Maximum Continuous Output Drive Current
(Source) per Output ..... 25 mA
Maximum Continuous Output Power
(Source) per Output ‡ ..... 50 mW
‡ $P_{OHmax} = I_{OH}(V_{DD}-V_{OH})$.

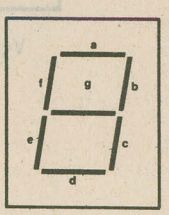
PIN CONNECTION



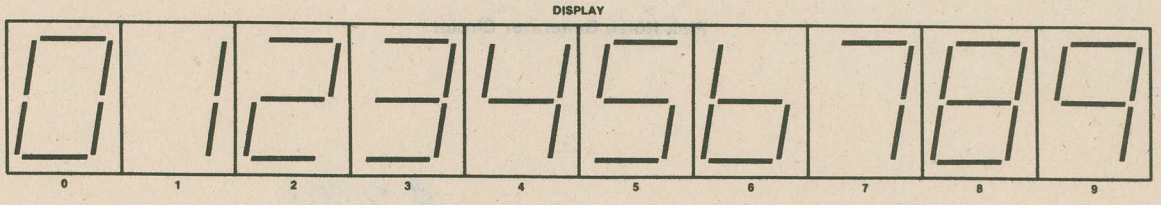
TRUTH TABLE

INPUTS							OUTPUTS							
LE	$\overline{BI}$	$\overline{LT}$	D	D	B	A	a	b	c	d	e	f	g	Display
X	X	L	X	X	X	X	H	H	H	H	H	H	H	8
X	L	H	X	X	X	X	L	L	L	L	L	L	L	Blank
L	H	H	L	L	L	L	H	H	H	H	H	H	L	0
L	H	H	L	L	L	H	L	H	H	L	L	L	L	1
L	H	H	L	L	H	L	H	H	L	H	H	L	H	2
L	H	H	L	L	H	H	H	H	H	H	L	L	H	3
L	H	H	L	H	L	L	L	H	H	L	L	H	H	4
L	H	H	L	H	L	H	H	L	H	H	L	H	H	5
L	H	H	L	H	H	L	L	L	H	H	H	H	H	6
L	H	H	L	H	H	H	H	H	H	L	L	L	L	7
L	H	H	H	L	L	L	H	H	H	H	H	H	H	8
L	H	H	H	L	L	H	H	H	H	L	L	H	H	9
L	H	H	H	L	H	L	L	L	L	L	L	L	L	Blank
L	H	H	H	L	H	H	L	L	L	L	L	L	L	Blank
L	H	H	H	H	L	L	L	L	L	L	L	L	L	Blank
L	H	H	H	H	L	H	L	L	L	L	L	L	L	Blank
L	H	H	H	H	H	L	L	L	L	L	L	L	L	Blank
L	H	H	H	H	H	H	L	L	L	L	L	L	L	Blank
H	H	H	X	X	X	X				*				*

X = Don't Care
L = Low Level
H = High Level
* Depends upon the BCD code previously applied when LE = L



DISPLAY



S2688
276-1768

DIGITAL NOISE GENERATOR

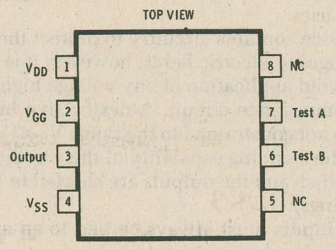
GENERAL DESCRIPTION

The S2688 noise generator circuit is fabricated in p-channel ion implanted MOS technology and supplied in an eight lead dual in-line plastic package. The device contains a 17-bit shift register which is continuously clocked by an internal oscillator. Exclusive OR feedback from the 14th and 17th stages causes the register to generate a pseudo-random noise pattern, and an internal gate is included to prevent the register from reaching an all zero lockup state. To facilitate testing, the device can be easily clocked by an external source.

FEATURES

- Internal oscillator
- Consistent noise quality
- Consistent noise amplitude
- Zero state lockup prevention
- Zeros can be externally forced into the register
- Oscillator can be driven externally
- Operates with single or dual power supplies
- Eliminates noise preamps
- Alternate to MM5837

PIN CONNECTION



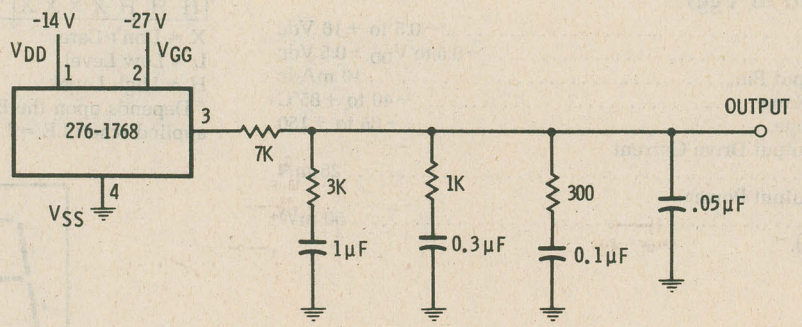
APPLICATIONS

Percussion instrument voice generators for rhythm units, electronic music synthesizers, simulated pipe "wind" noise, acoustics testing.

ABSOLUTE MAXIMUM RATINGS

Positive Voltage on Any Pin: ..... V_{SS} +0.3 volts
Negative Voltage on Any Pin Except V_{GG}: ..... V_{SS} −28 volts
Negative Voltage on V_{GG} Supply Pin: ..... V_{SS} −33 volts
Storage Temperature: ..... −65°C to +150°C
Operating Ambient Temperature: ..... 0°C to +70°C

TYPICAL APPLICATION



Pink Noise Generator Circuit

$3.99

P.125

5.8 W AF POWER AMPLIFIER

BA521
276-704

GENERAL DESCRIPTION

The BA521 is a general replacement audio amplifier IC for audio output stages in many imported tape decks, auto sound units, radios, etc. It is also useful for experimental audio amplifiers where high gain and low distortion are important criteria.

FEATURES

- 5.8 W output (THD=10%)
- High gain (55 dB)
- Built-in heat sink/mounting tab
- Lower distortion than comparable audio amplifier ICs

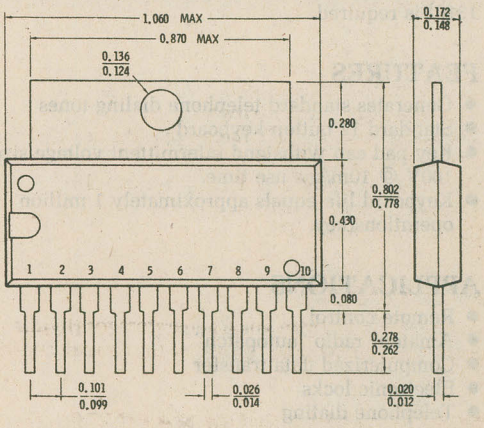
APPLICATIONS

- General replacement in audio output stages of car radios/stereos, tape decks, portable radios, etc.
- Audio amplifiers where high gain is important

ABSOLUTE MAXIMUM RATINGS

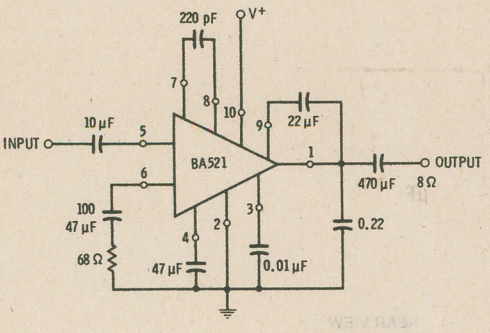
Operating Voltage	12-14V
Gain	55db
Power Output	5.8W
Total Harmonic Distortion	10%

PIN CONNECTION

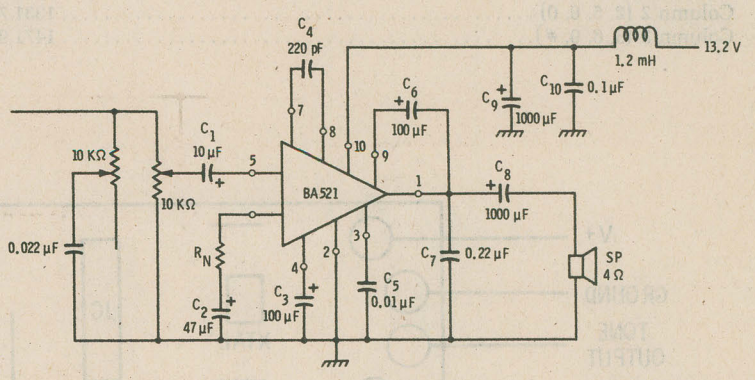


PIN	FUNCTION
1	Output
2	Ground
3	Distortion Correction
4	Decoupling
5	Input
6	Negative Feedback
7	Phase Compensation
8	Phase Compensation
9	Bootstrap
10	V_{CC}

TYPICAL APPLICATION



Audio Amplifier



Audio Amplifier

$2.49

P.125

CEX-4000 12-KEY PUSHBUTTON TONE MODULE

277-1010

GENERAL DESCRIPTION

The CEX-4000 twelve-key push-button tone module consists of a 12 key keyboard and P.C. board with the tone encoding electronics. The CEX-4000 generates standard telephone dialing tones for such applications as remote control, amateur radio "autopatch," electronic locks, etc. Standard telephone markings are provided on the keyboard. A 3.579545 MHz color burst crystal (Radio Shack Cat. No. 272-1310) is required.

FEATURES

- Generates standard telephone dialing tones
- Standard 12 button keyboard
- Key pad can withstand intermittent voltage sizes up to 100V @ 10m/sec use time.
- Keyboard life equals approximately 1 million operations/key.

APPLICATIONS

- Remote control
- Amateur radio "autopatch"
- Computerized data transfer
- Electronic locks
- Telephone dialing

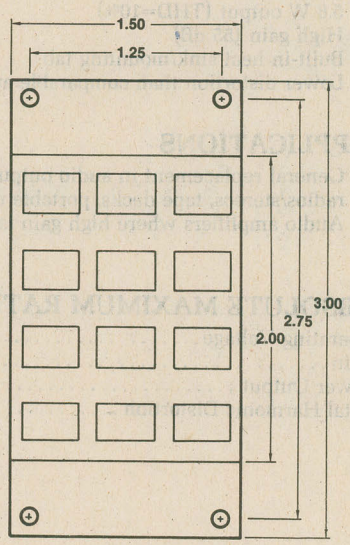
ABSOLUTE MAXIMUM RATINGS

Voltage	6VDC
Current	20mA
Overall Freq. Accuracy	±0.5%
Operating Temp. Range	−25°C to +70°C

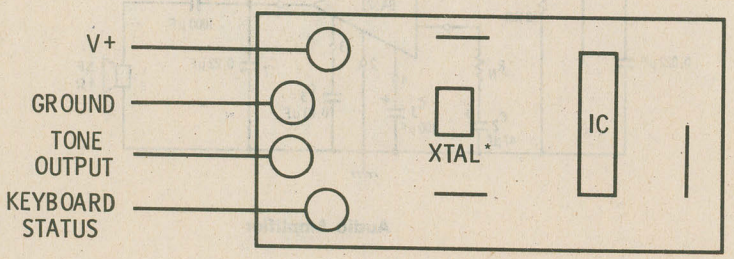
OSCILLATOR FREQUENCIES

Row 1 (1, 2, 3)	699.1Hz
Row 2 (4, 5, 6)	766.2Hz
Row 3 (7, 8, 9)	847.4Hz
Row 4 (*, 0, #)	948.0Hz
Column 1 (1, 4, 7, *)	1215.9Hz
Column 2 (2, 5, 8, 0)	1331.7Hz
Column 3 (3, 6, 9, #)	1471.9Hz

PIN CONNECTION



FRONT VIEW



REAR VIEW

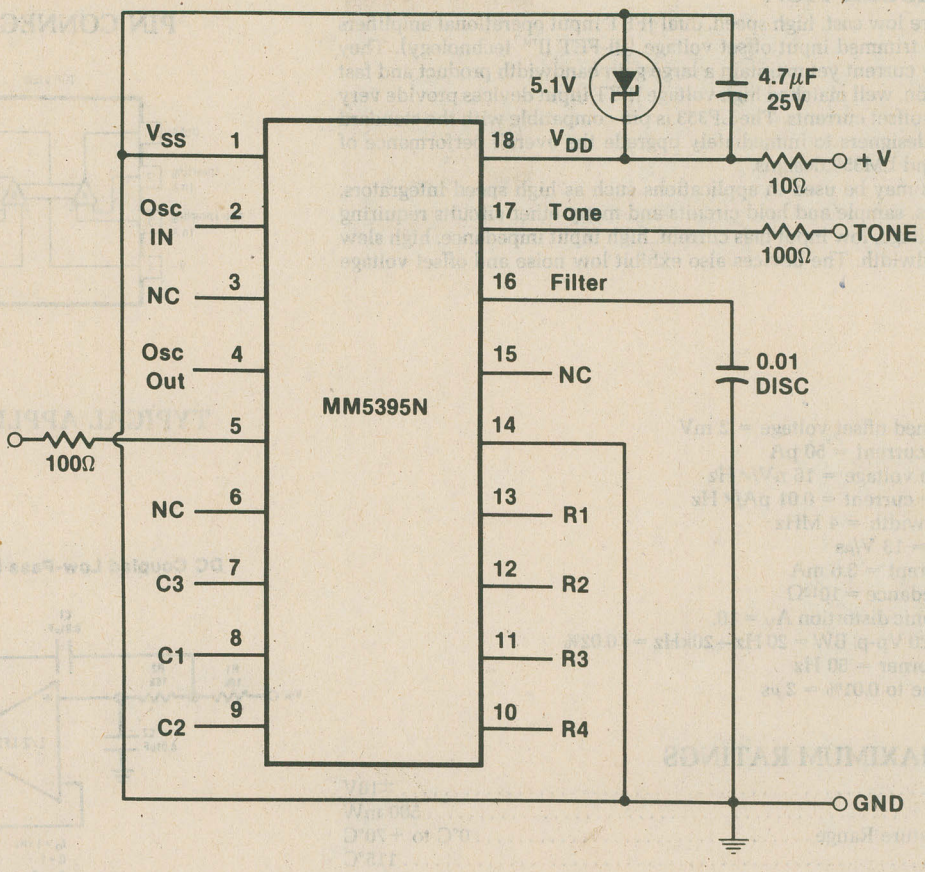
*Not supplied with module

19.95

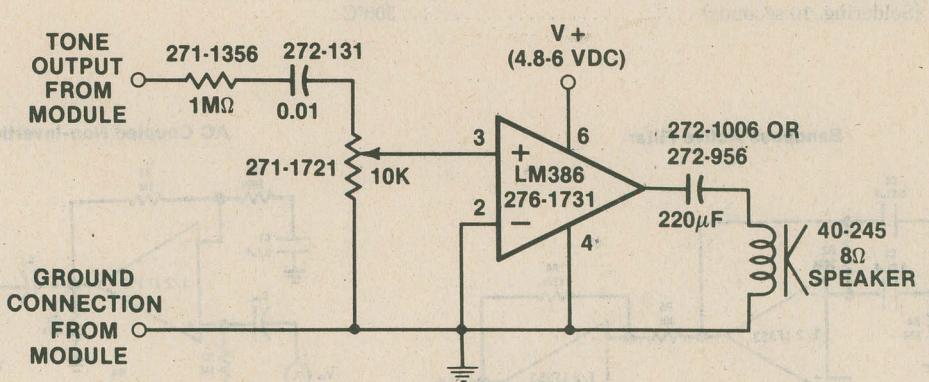
P.124

CEX-4000 (277-1010)

INTERNAL CIRCUIT



TYPICAL APPLICATION



Driving a Speaker

amp 2.29 SP. 83.39

P 125 P. 58

LF353N
276-1715

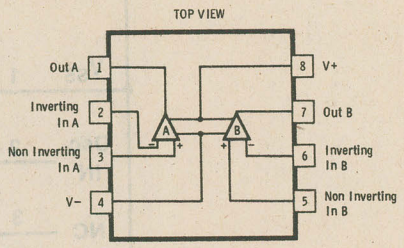
WIDE BANDWIDTH DUAL JFET INPUT OPERATIONAL AMPLIFIER

GENERAL DESCRIPTION

These devices are low cost, high speed, dual JFET input operational amplifiers with an internally trimmed input offset voltage (BI-FET II™ technology). They require low supply current yet maintain a large gain bandwidth product and fast slew rate. In addition, well matched high voltage JFET input devices provide very low input bias and offset currents. The LF353 is pin compatible with the standard LM1558 allowing designers to immediately upgrade the overall performance of existing LM1558 and LM358 designs.

These amplifiers may be used in applications such as high speed integrators, fast D/A converters, sample and hold circuits and many other circuits requiring low input offset voltage, low input bias current, high input impedance, high slew rate and wide bandwidth. The devices also exhibit low noise and offset voltage drift.

PIN CONNECTION

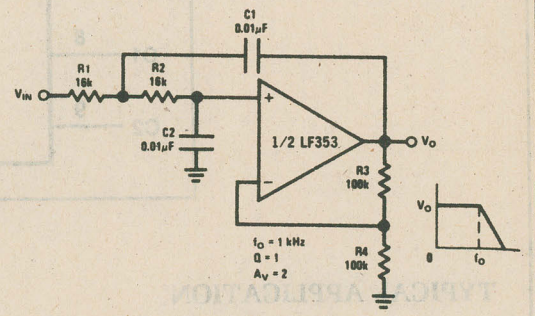


FEATURES

- Internally trimmed offset voltage = 2 mV
- Low input bias current = 50 pA
- Low input noise voltage = 16 nV/√Hz
- Low input noise current = 0.01 pA/√Hz
- Wide gain bandwidth = 4 MHz
- High slew rate = 13 V/μs
- Low supply current = 3.6 mA
- High input impedance = $10^{12}\Omega$
- Low total harmonic distortion $A_V = 10$, $R_L = 10k$, $V_O = 20$ Vp-p, BW = 20 Hz—20kHz = <0.02%
- Low 1/f noise corner = 50 Hz
- Fast settling time to 0.01% = 2 μs

TYPICAL APPLICATIONS

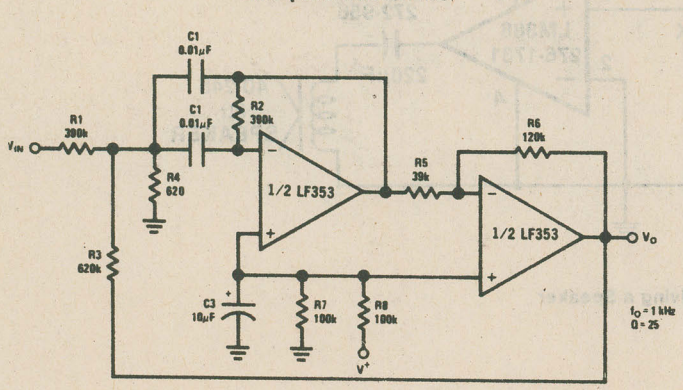
DC Coupled Low-Pass RC Active Filter



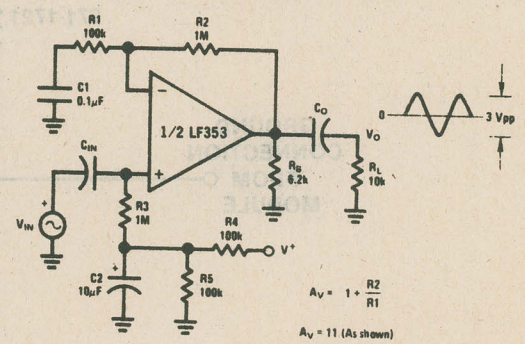
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18V
Power Dissipation	500 mW
Operating Temperature Range	0°C to +70°C
$T_{j(MAX)}$	115°C
Differential Input Voltage	±30V
Input Voltage Range	±15V
Output Short Circuit Duration	Continuous
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Bandpass Active Filter



AC Coupled Non-Inverting Amplifier

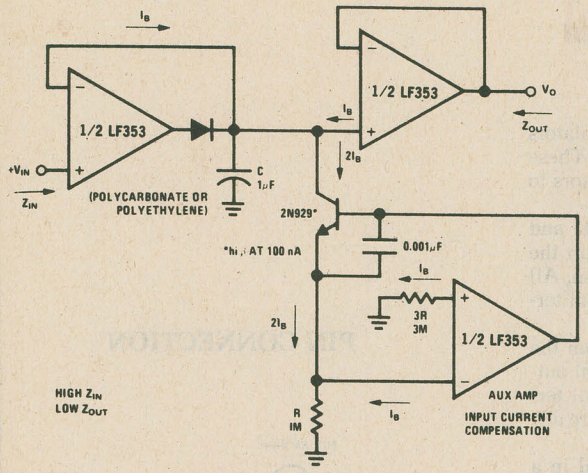


$2.49

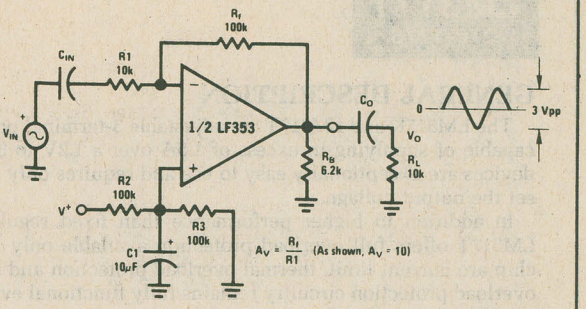
B125

LF353N (276-1715)

Low Drift Peak Detector

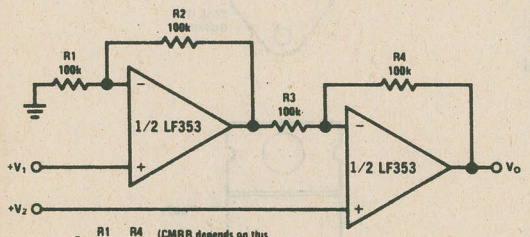


AC Coupled Inverting Amplifier



$A_V = \frac{R_f}{R1}$ (As shown, $A_V = 10$)

High Input Z, DC Differential Amplifier

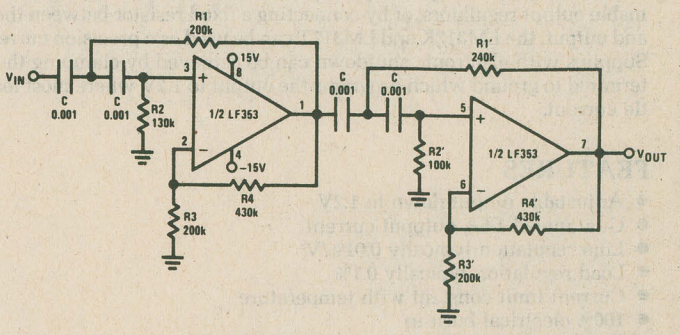


For $\frac{R1}{R2} = \frac{R4}{R3}$ (CMRR depends on this resistor ratio match)

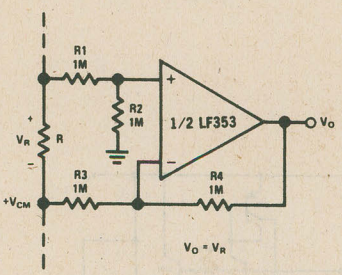
$V_O = 1 + \frac{R4}{R3} (V_2 - V_1)$

As shown: $V_O = 2(V_2 - V_1)$

Fourth Order High Pass Butterworth Filter

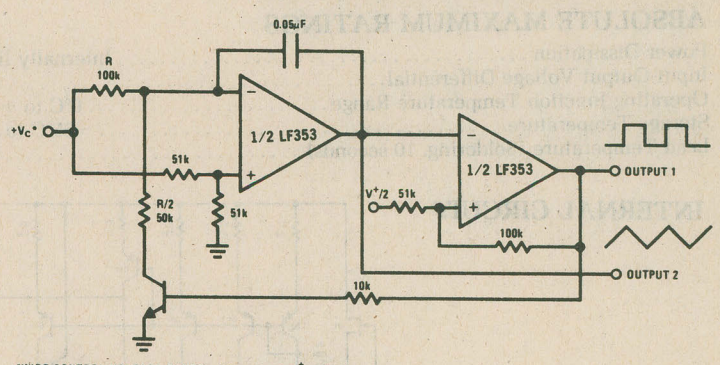


Ground Referencing A Differential Input Signal



$V_O = V_R$

Voltage Controlled Oscillator (VCO)



*WIDE CONTROL VOLTAGE RANGE: $0\ V_{DC} < V_C < 2\ (V^+ - 1.5V_{DC})$

LM317K 276-1777 LM317T 276-1778 3-TERMINAL ADJUSTABLE POSITIVE REGULATOR

GENERAL DESCRIPTION

The LM317K and LM317T are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 1.5A over a 1.2V to 37V output range. These devices are exceptionally easy to use and requires only two external resistors to set the output voltage.

In addition to higher performance than fixed regulators, the LM317K and LM317T offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

Normally, no capacitors are needed unless the device is situated far from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejections ratios which are difficult to achieve with standard 3-terminal regulators.

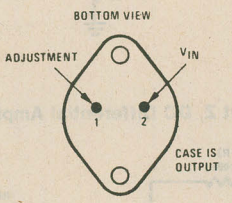
Besides replacing fixed regulators, the LM317K and LM317T are useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded.

Also, they make expecially simple adjustable switching regulators, programmable output regulators, or by connecting a fixed resistor between the adjustment and output, the LM317K and LM317T can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

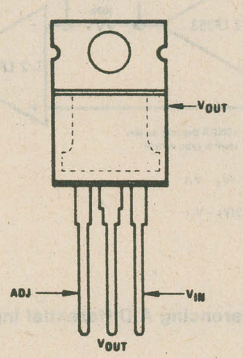
FEATURES

- Adjustable output down to 1.2V
- Guaranteed 1.5A outpput current
- Line regulation typically 0.01%/V
- Load regulation typically 0.1%
- Current limit constant with temperature
- 100% electrical burn-in
- Eliminates the need to stock many voltages
- Standard 3-lead transistor package
- 80 dB ripple rejection

PIN CONNECTION



LM317K

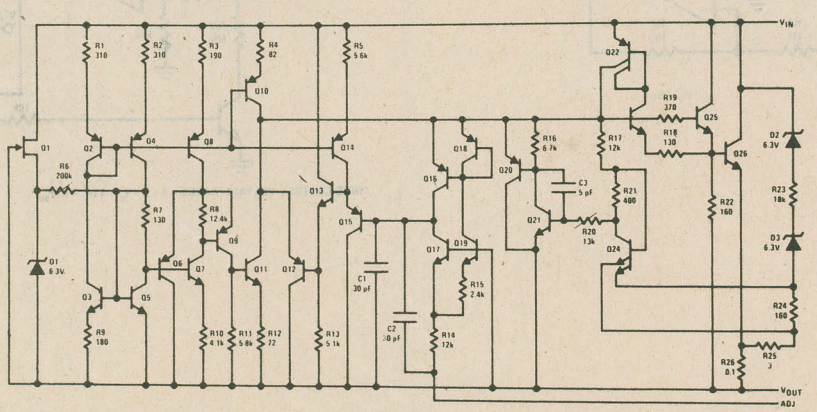


LM317T

ABSOLUTE MAXIMUM RATINGS

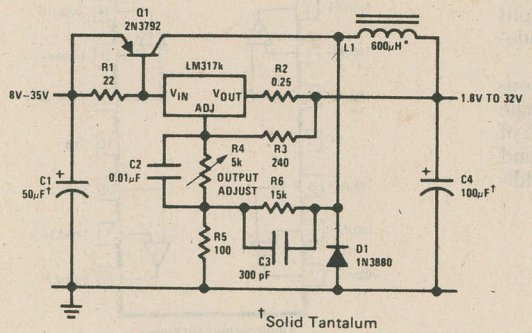
Power Dissipation	Internally limited
Input-Output Voltage Differential	40V
Operating Junction Temperature Range	0°C to +125°C
Storage Temperature	−65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

INTERNAL CIRCUIT



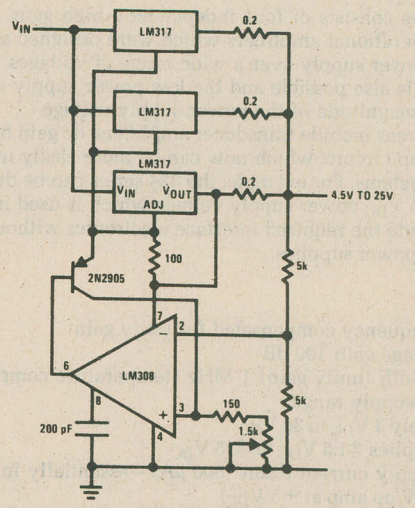
LM317K (276-1777) LM317T (276-1778)

TYPICAL APPLICATIONS

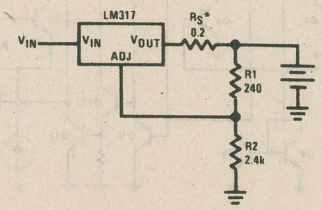


†Solid Tantalum
*Core–Arnold A-254168-2 60 turns

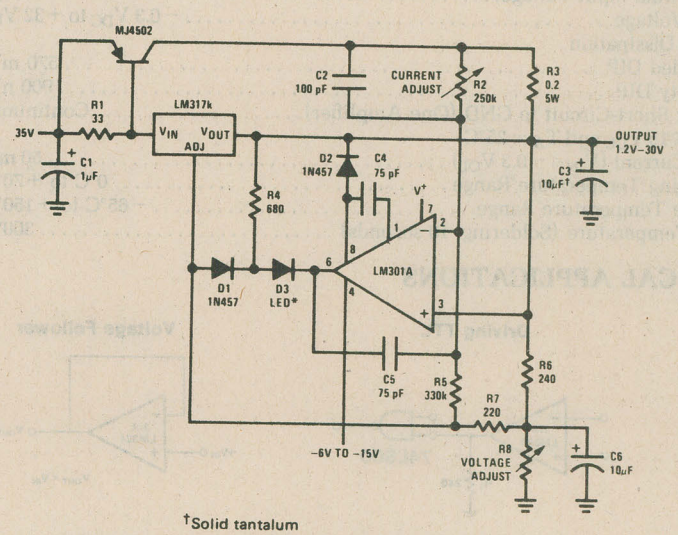
Low Cost 3A Switching Regulator



Adjustable 4A Regulator

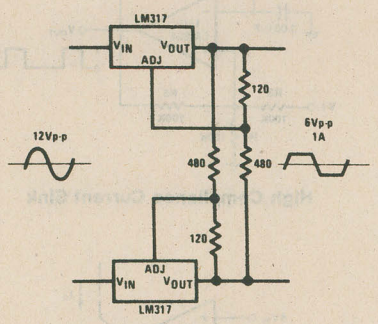


12V Battery Charger



†Solid tantalum
*Lights in constant current mode

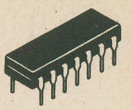
5A Constant Voltage/Constant Current Regulator



AC Voltage Regulator

LM324 QUAD OP AMP

276-1711



GENERAL DESCRIPTION

The 324 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the 324 series can be directly operated off of the standard +5 V_{DC} power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional +15 V_{DC} power supplies.

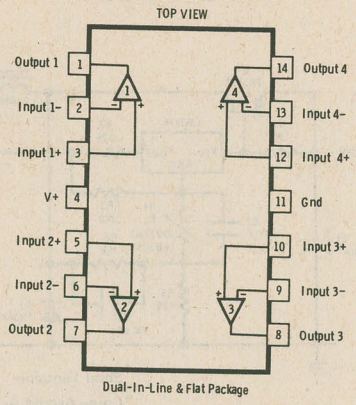
FEATURES

- Internally frequency compensated for unity gain
- Large dc voltage gain 100 dB
- Wide bandwidth (unity gain) 1 MHz (temperature compensated)
- Wide power supply range:
  Single supply 3 V_{DC} to 30 V_{DC}
  or dual supplies ±1.5 V_{DC} to ±15 V_{DC}
- Very low supply current drain (800 μA)—essentially independent of supply voltage (1 mW/op amp at +5 V_{DC})
- Low input biasing current 45 nA_{DC} (temperature compensated)
- Low input offset voltage 2 mV_{DC} and offset current 5 nA_{DC}
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V_{DC} to V^+ −1.5 V_{DC}

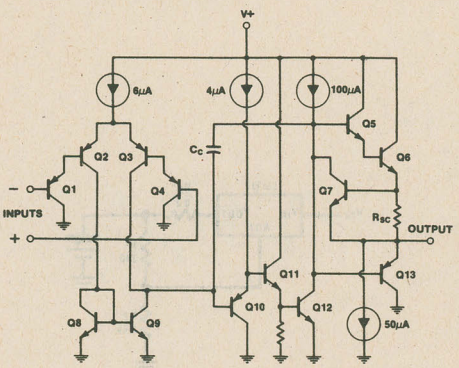
ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V^+	32 V_{DC} or ±16 V_{DC}
Differential Input Voltage	32 V_{DC}
Input Voltage	−0.3 V_{DC} to +32 V_{DC}
Power Dissipation	
Molded DIP	570 mW
Cavity DIP	900 nW
Output Short-Circuit to GND (One Amplifier)	Continuous
$V^+ \leq 15$ V_{DC} and $T_A = 25°C$	
Input Current ($V_{IN} < -0.3$ V_{OL})	50 mA
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

PIN CONNECTION

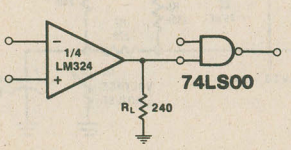


INTERNAL CIRCUIT (Each Amplifier)

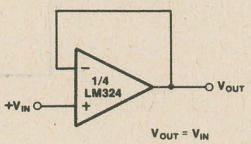


TYPICAL APPLICATIONS

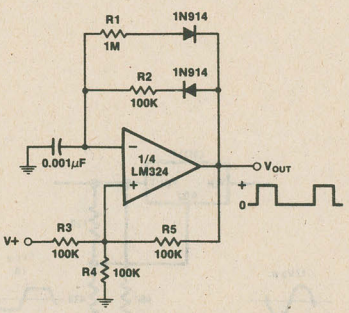
Driving TTL



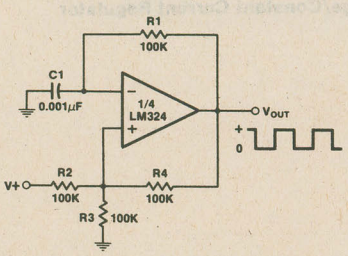
Voltage Follower



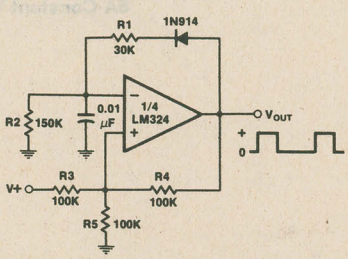
Pulse Generator



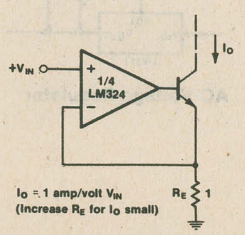
Squarewave Oscillator



Pulse Generator



High Compliance Current Sink



3-TERMINAL ADJUSTMENT CURRENT SOURCES AND TEMPERATURE SENSOR

LM334
276-1734

GENERAL DESCRIPTION

The LM334 is a 3-terminal adjustable current source featuring 10,000:1 range in operating current, excellent current regulation and a wide dynamic voltage range of 1V to 40V. Current is established with one external resistor and no other parts are required. Initial current accuracy is ±3%. The LM334 is a true floating current source with no separate power supply connections. In addition, reverse applied voltages of up to 20V will draw only a few microamperes of current, allowing the device to act as both a rectifier and current source in AC applications.

The LM334 is guaranteed over a temperature range of 0°C to +70°C.

FEATURES

- Operates from 1V to 40V
- 0.02%/V current regulation
- Programmable from 1 μA to 10 mA
- True 2-terminal operation

APPLICATIONS

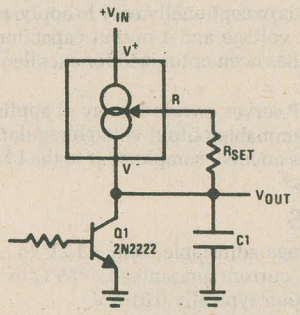
Applications for the new current sources include bias networks, surge protection, low power reference, ramp generation LED driver, and temperature sensing.

ABSOLUTE MAXIMUM RATINGS

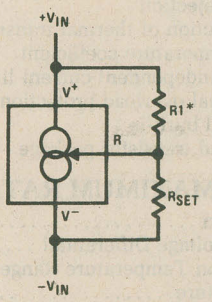
V+ to V− Forward Voltage	30V
V+ to V− Reverse Voltage	20V
R Pin to V− Voltage	5V
Set Current	10 mA
Power Dissipation	200 mW
Operating Temperature Range	0°C to +70°C
Lead Temperature (Soldering, 10 seconds)	300°C

TYPICAL APPLICATIONS

Ramp Generator

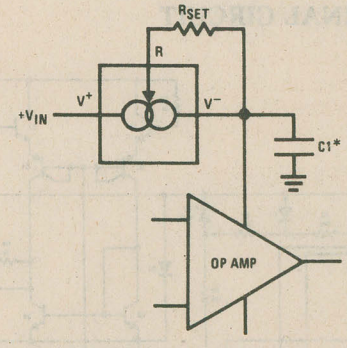


Generating Negative Output Impedance



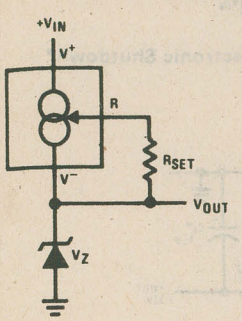
*$Z_{OUT} \approx 16 \cdot R1$ ($R1/V_{IN}$ must not exceed I_{SET})

In-Line Current Limiter

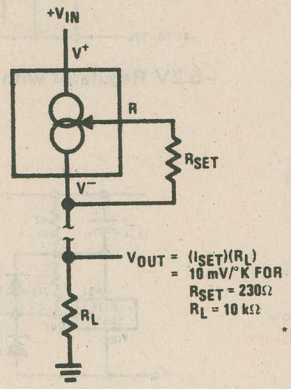


*Use minimum value required to ensure stability of protected device. This minimizes inrush current to a direct short.

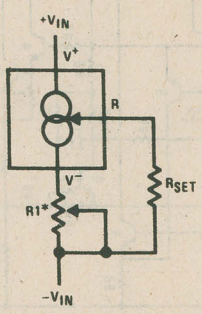
Zener Biasing



Terminating Remote Sensor for Voltage Output

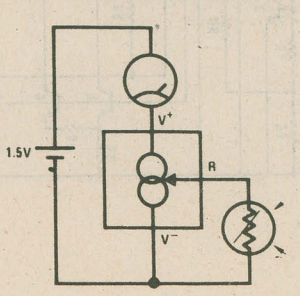


Alternate Trimming Technique



*For ±10% adjustment, select R_{SET} 10% high, and make R1 ≈ 3 R_{SET}

Buffer for Photoconductive Cell



NOTE: $R_{SET} = \frac{67.7}{I_{SET}}$ @25°C I_{SET} = current flowing into the V+ pin.

LM337T 276-1779 ADJUSTABLE NEGATIVE VOLTAGE REGULATOR

GENERAL DESCRIPTION

The LM337T is an adjustable 3-terminal negative voltage regulator capable of supplying in excess of −1.5A over an output voltage range of −1.2V to −37V. This regulator is exceptionally easy to apply, requiring only 2 external resistors to set the output voltage and 1 output capacitor for frequency compensation. The circuit design has been optimized for excellent regulation and low thermal transients.

The LM337T serves a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM337T is an ideal complement to the LM317K and LM317T adjustable positive regulators.

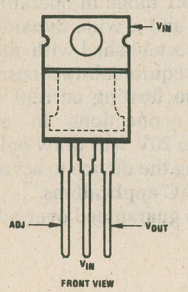
FEATURES

- Output voltage adjustable from −1.2V to −37V
- 1.5A output current guaranteed, −55°C to +150°C
- Line regulation typically 0.01%/V
- Load regulation typically 0.3%
- Excellent thermal regulation, 0.002%/W
- 77 dB ripple rejection
- Excellent rejection of thermal transients
- 50 ppm/°C temperature coefficient
- Temperature-independent current limit
- Internal thermal overload protection
- 100% electrical burn-in
- Standard 3-lead transistor package

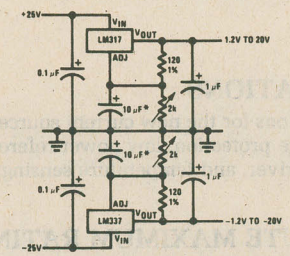
ABSOLUTE MAXIMUM RATINGS

Power Dissipation	Internally limited
Input—Output Voltage Differential	40V
Operating Junction Temperature Range	0°C to +125°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

PIN CONNECTION

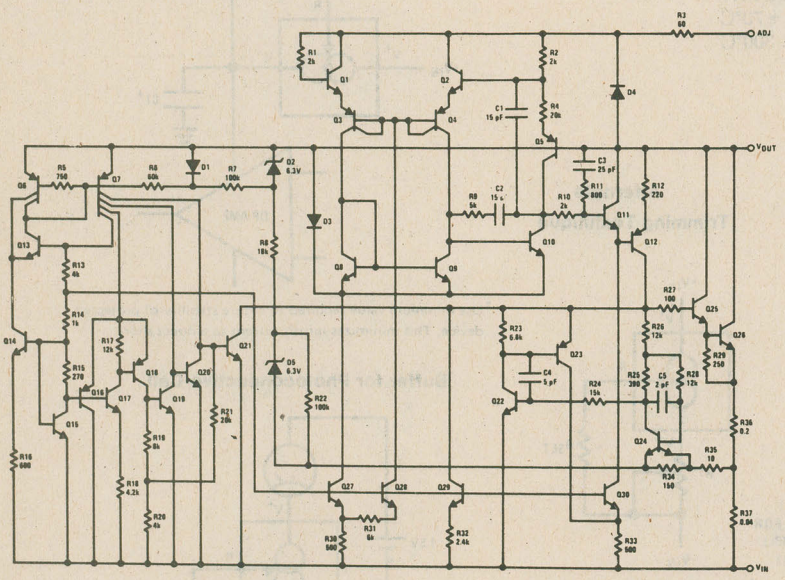


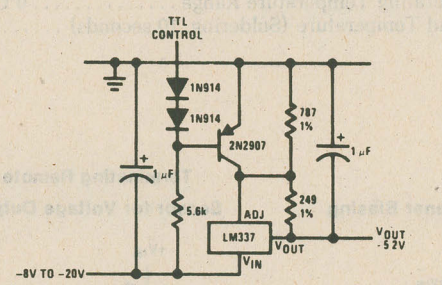
TYPICAL APPLICATIONS



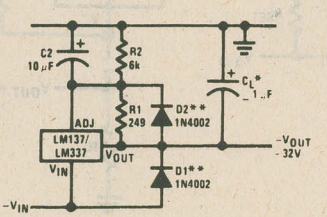
Adjustable Lab Voltage Regulator

INTERNAL CIRCUIT





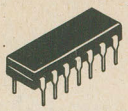
−5.2V Regulator with Electronic Shutdown*



Negative Regulator with Protection Diodes

$3.49

P 125



QUAD COMPARATOR LM339

276-1712

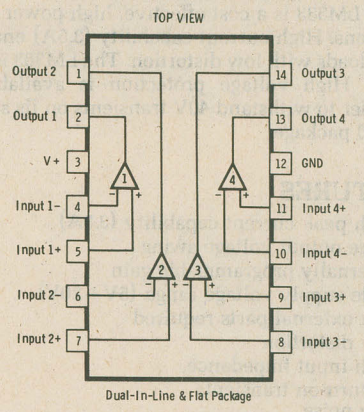
GENERAL DESCRIPTION

The 339 series consists of four independent voltage comparators which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

FEATURES

- Wide single supply:
  Voltage range 2 V_{DC} to 32 V_{DC} or dual supplies ± 1 V_{DC} to ± 16 V_{DC}
- Very low supply current drain (0.8 mA)—independent of supply voltage (1 mW/comparator at +5 V_{DC})
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output 1 mV at 5 μA; saturation voltage 70 mV at 1 mA
- Output voltage compatible with TTL (fanout of 2), DTL, ECL, MOS and CMOS logic systems

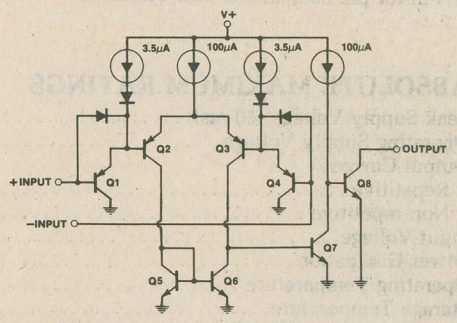
PIN CONNECTION



ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+	32 V_{DC} or ± 16 V_{DC}
Differential Input Voltage	36 V_{DC}
Input Voltage	−0.3 V_{DC} to +36 V_{DC}
Power Dissipation	
Molded DIP	570 mW
Cavity DIP	900 mW
Output Short-Circuit to GND	Continuous
Input Current (V_{IN} < −0.3 V_{DC})	50 mA
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

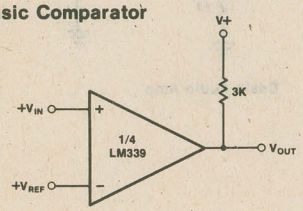
INTERNAL CIRCUIT



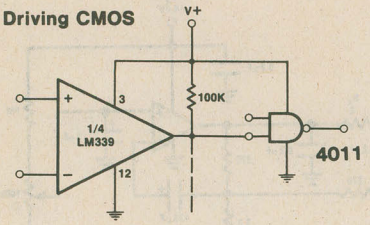
TYPICAL APPLICATIONS

5 VOLT GROUP

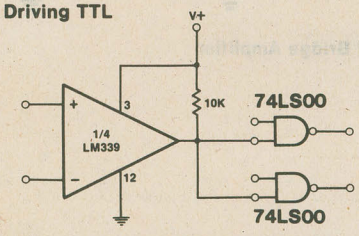
Basic Comparator



Driving CMOS

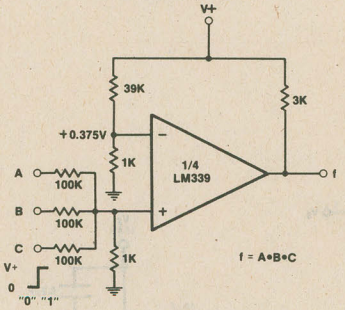


Driving TTL

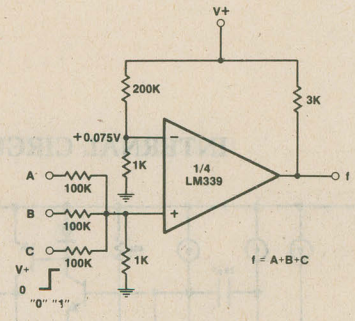


15V GROUP

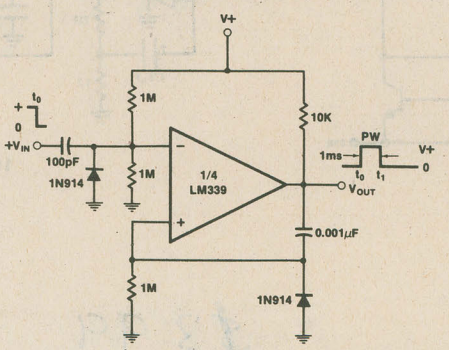
AND Gate



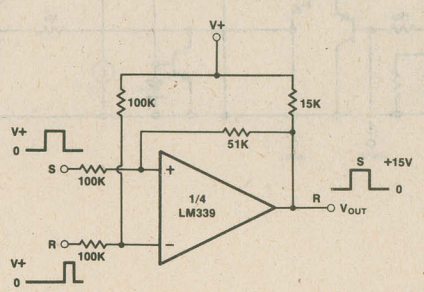
OR Gate



One-Shot Multivibrator



Bi-Stable Multivibrator



LM383/TDA2002
276-703

8 WATT AUDIO POWER AMPLIFIER

GENERAL DESCRIPTION

The LM383 is a cost effective, high power amplifier suited for automotive applications. High current capability (3.5A) enables the device to drive low impedance loads with low distortion. The LM383 is current limited and thermally protected. High voltage protection is available (LM383A) which enables the amplifier to withstand 40V transients on its supply. The LM383 comes in a 5-pin TO-220 package.

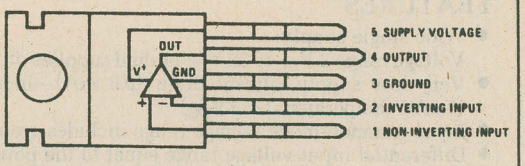
FEATURES

- High peak current capability (3.5A)
- Large output voltage swing
- Externally programmable gain
- Wide supply voltage range (5V—20V)
- Few external parts required
- Low distortion
- High input impedance
- No turn-on transients
- Low noise
- Short circuit protected
- Pin for pin compatible with TDA2002

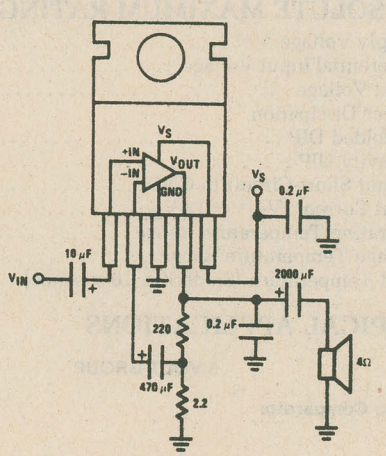
ABSOLUTE MAXIMUM RATINGS

Peak Supply Voltage (50 ms)	25V
Operating Supply Voltage	20V
Output Current	
Repetitive	3.5A
Non-repetitive	4.5A
Input Voltage	±0.5V
Power Dissipation	15W
Operating Temperature	0°C to +70°C
Storage Temperature	−60°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

PIN CONNECTION

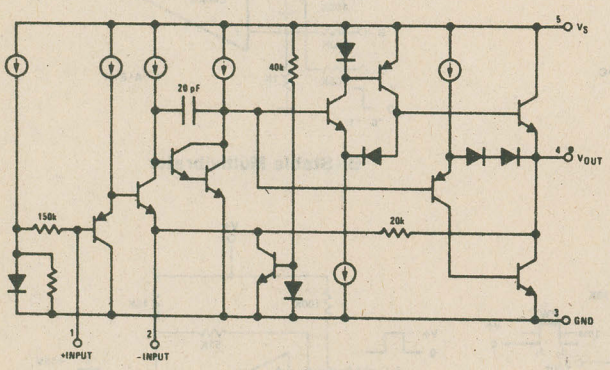


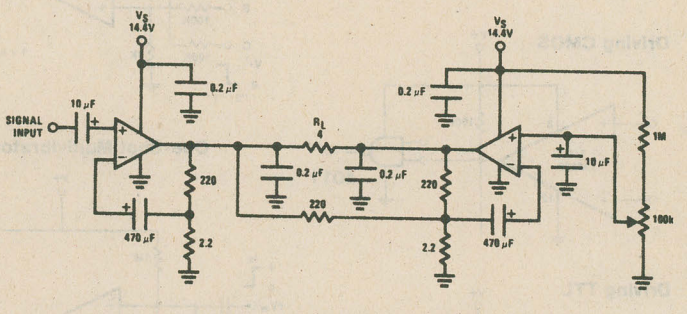
TYPICAL APPLICATIONS



Basic Audio Amp

INTERNAL CIRCUIT

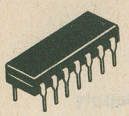




16W Bridge Amplifier

$3.99

P.125



DUAL-CHANNEL POWER AUDIO AMPLIFIER

LM1877N-9
276-702

GENERAL DESCRIPTION

The LM1877N-9 is a monolithic dual power amplifier designed to deliver 2W/channel continuous into 8Ω loads. The LM1877N-9 is designed to operate with a low number of external components, and still provide flexibility for use in stereo phonographs, tape recorders and AM-FM stereo receivers, etc. Each power amplifier is biased from a common internal regulator to provide high power supply rejection, and output Q point centering. The LM1877N-9 is internally compensated for all gains greater than 10, and is a pin-for-pin replacement for the LM377 in audio applications.

FEATURES

- Wide supply range, 6—24V
- Very low cross-over distortion
- Low audio band noise
- Internal current limiting, short circuit protection
- Internal thermal shutdown
- 2W/channel
- −65 dB ripple rejection, output referred
- −65 dB channel separation, output referred

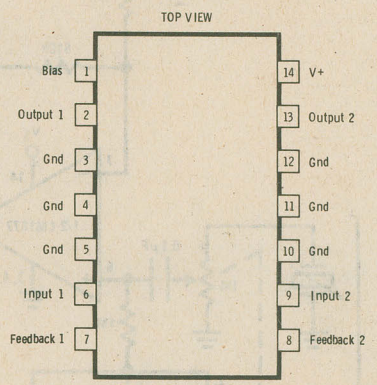
APPLICATIONS

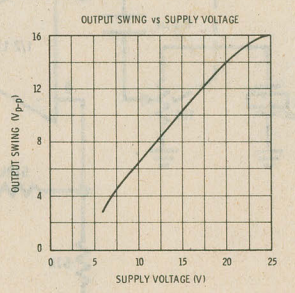
- Multi-channel audio systems
- Stereo phonographs
- Tape recorders and players
- AM—FM radio receivers
- Servo amplifiers
- Intercom systems
- Automotive products

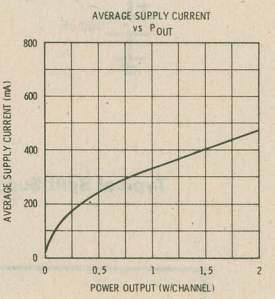
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	26V
Input Voltage	±0.7V
Operating Temperature	0°C to +70°C
Storage Temperature	−65°C to +150°C
Junction Temperature	150°C
Lead Temperature (Soldering, 10 seconds)	300°C

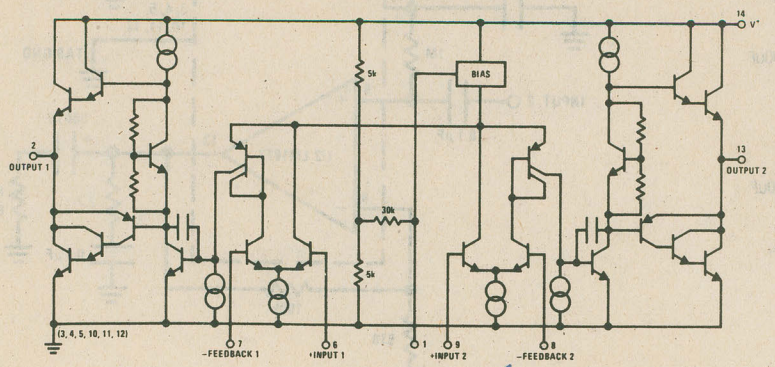
PIN CONNECTION

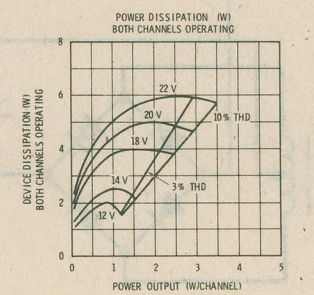






INTERNAL CIRCUIT





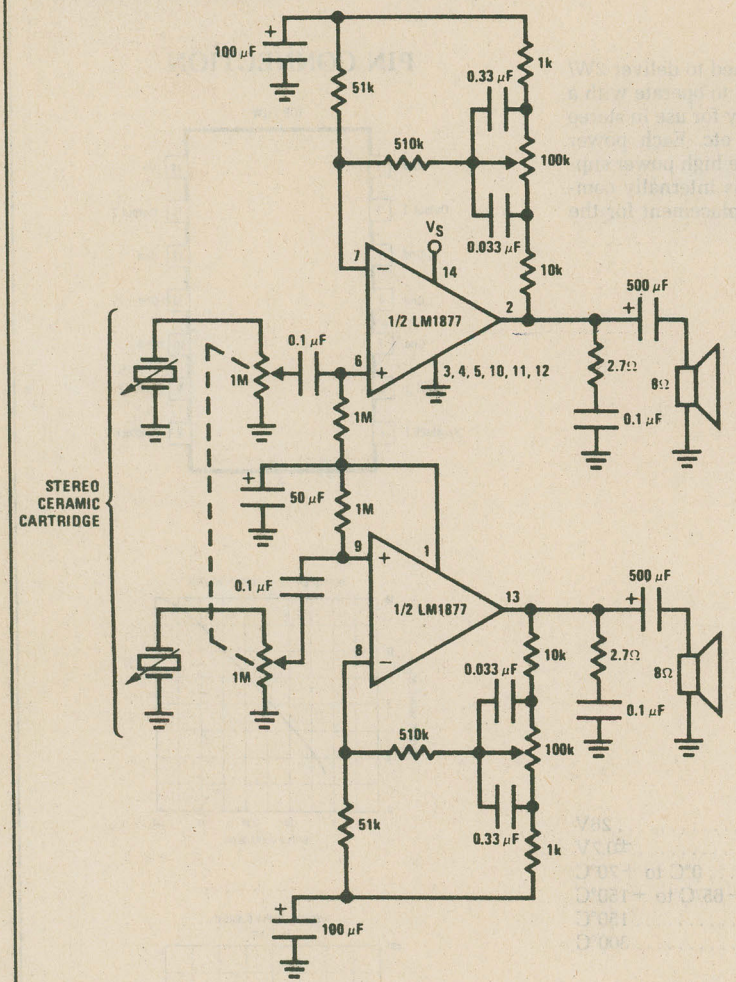
$3.99

P125

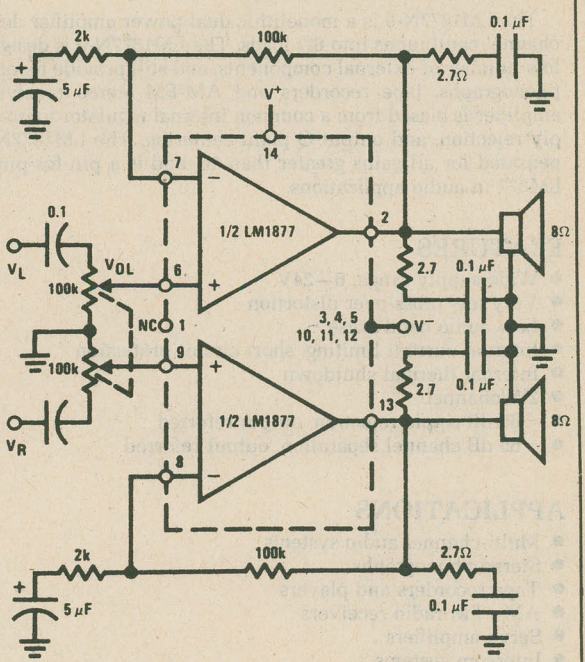
LM1877N-9 (276-702)

TYPICAL APPLICATIONS

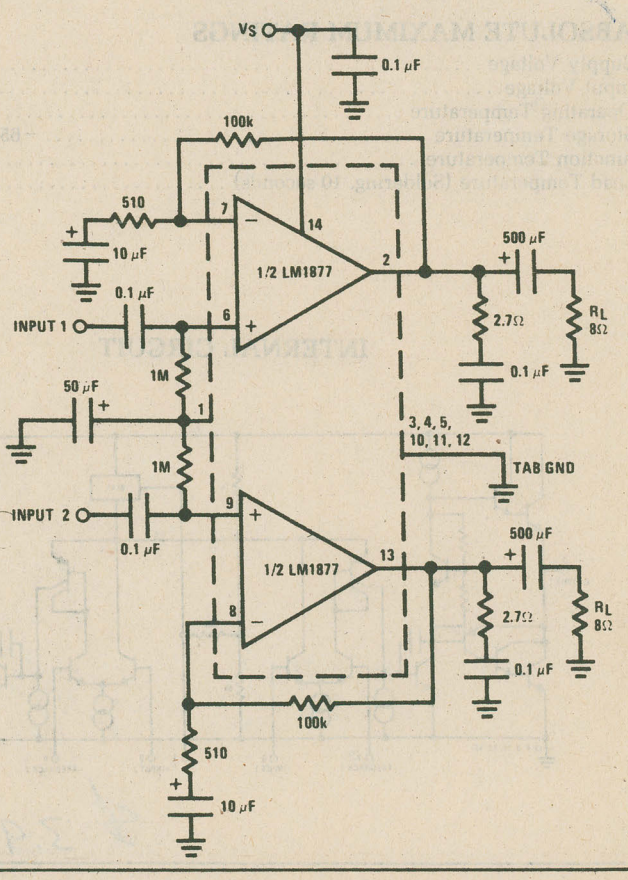
Stereo Phonograph Amplifier with Bass Tone Control



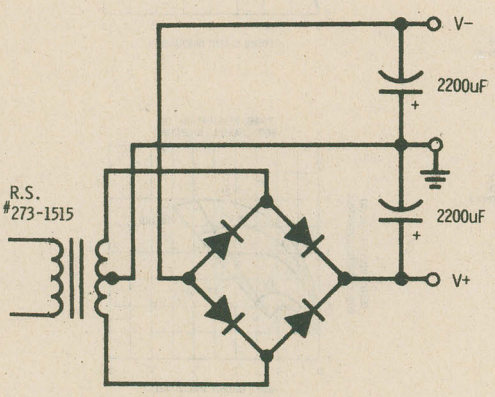
Non-Inverting Amplifier Using Split Supply

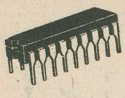


Stereo Amplifier with Gain = 200



Typical Split Supply





DOT/BAR DISPLAY DRIVER

LM3914
276-1707

LM3915
276-1708

GENERAL DESCRIPTION

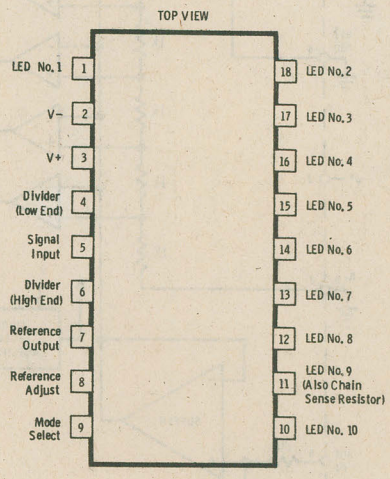
The LM3914 is a monolithic integrated circuit that senses analog voltage levels and drives 10 LEDs, providing a linear analog display. A single pin changes the display from a moving dot to a bar graph. Current drive to the LEDs is regulated and programmable, eliminating resistors. This feature allows operation of the system from less than 3V. Controller, visual alarm, and expanded scale functions are easily added on to the display system. The circuit can drive LEDs of many colors, or low-current incandescent lamps. Many LM3914s can be "chained" to form displays of segments. Both ends of the voltage divider are externally available so that 2 drivers can be made into a zero-center meter.

Individual DC regulated currents provide flexibility and various effects can be achieved by modulating these currents. Outputs can drive a transistor and a LED so controller functions including "staging" control can be performed.

The LM3915 Bar/Graph Display Driver is different by a −3db per segment logarithmic scaling compared to the linear scaling of the LM3914.

The LM3915 can be used with AC or DC signals. With AC (audio) inputs, the display will be quite eye-catching and informative, especially in the Dot mode. Connecting an audio signal to the signal input direct is all that is required.

PIN CONNECTION



FEATURES

- Bar or dot display mode externally selectable by user
- Expandable to displays of 20 steps (3915)
- Expandable to displays of 100 steps (3914)
- Internal voltage reference from 1.2V to 12V
- Operates with single supply of less than 3V
- Inputs operate down to ground
- Output current programmable from 2 to 30 mA
- No multiplex switching or interaction bewteen outputs
- Input withstands ±35V without damage or false outputs
- LED driver outputs are current regulated, open-collectors
- Outputs can interface with TTL or CMOS logic. The internal 10-step divider is floating and can be referenced to a wide range of voltages

APPLICATIONS

- "Slow"—fade bar or dot display (doubles resolution)
- 20 step meter with single pot brightness control
- 10-step (nor multiples) programmer
- Multi-step or "staging" controller
- Combined controller and process deviation meter
- Direction and rate indicator (to add to DVMs)
- Exclamation point display for power saving
- Power Meters in stereo systems
- VU Meters in tape recorders
- S meters in Ham and CB radios

ABSOLUTE MAXIMUM RATINGS

Power Dissipation

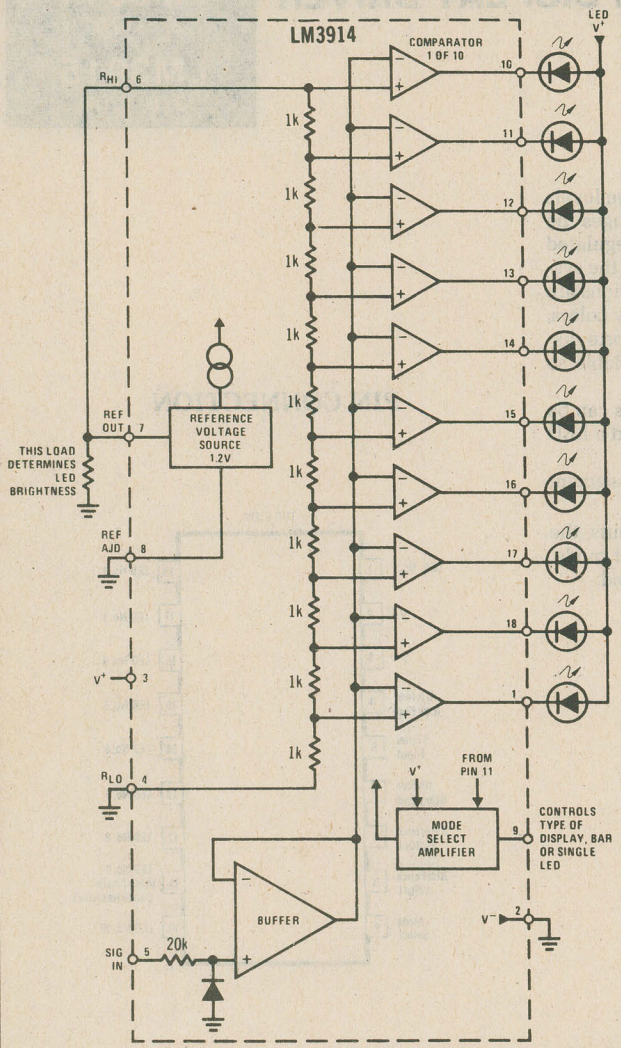
Molded DIP	660 mW
V^+ Voltage	25V
LED Collector Output Voltage	25V
Input Signal Overvoltage	±35V
Voltage on Resistor String	−100 mV to V^+
Reference Load Current	10 mA
Signal Input Current (With Overvoltage Applied)	±3 mA

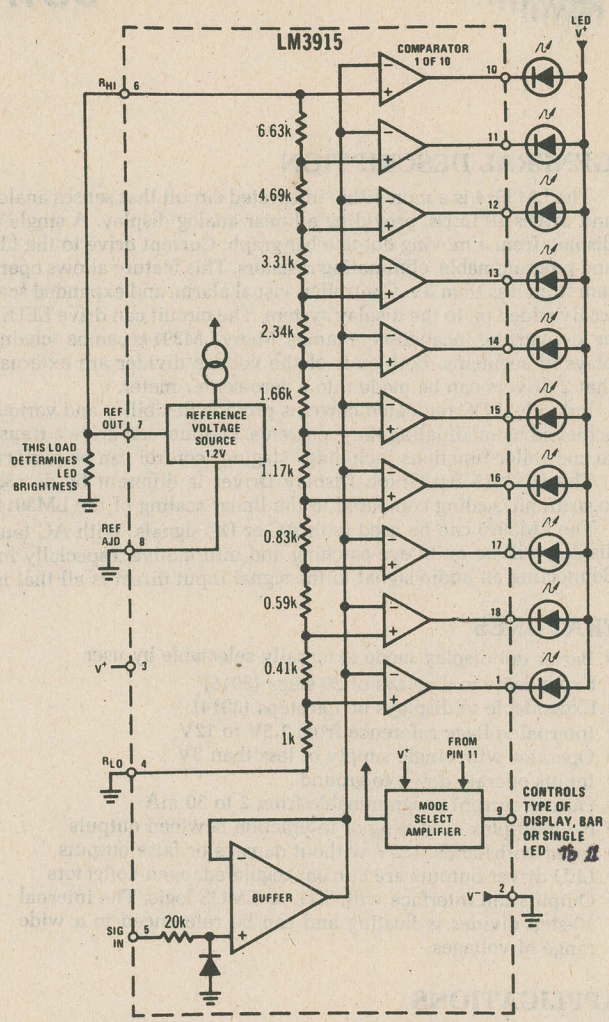
$5.49

P.125

LM3914 (276-1707) LM3915 (276-1708)

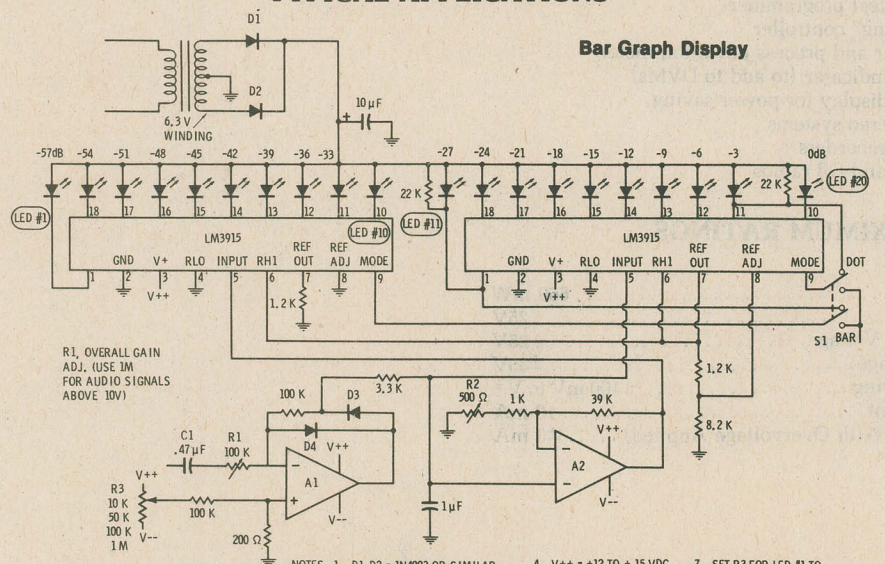
INTERNAL CIRCUIT





TYPICAL APPLICATIONS

Bar Graph Display



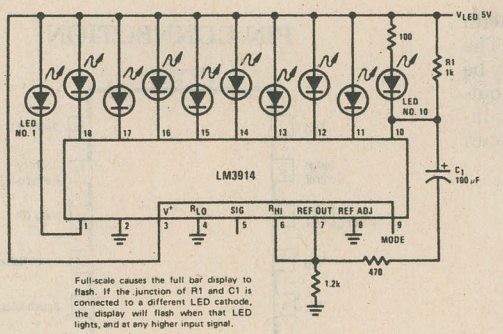
NOTES
1. D1, D2 = 1N4003 OR SIMILAR
2. D3, D4 = 1N914 OR SIMILAR
3. A1, A2 = LF351, 1/2 LF353 OR LF356
4. V++ = +12 TO + 15 VDC
5. V-- = -5 TO -15 VDC
6. SET R2 FOR LED #10 TO TURN ON 3dB BELOW LED #11
7. SET R3 FOR LED #1 TO TURN ON 57dB BELOW LED #20

A1, A2 $ 249

P. 125

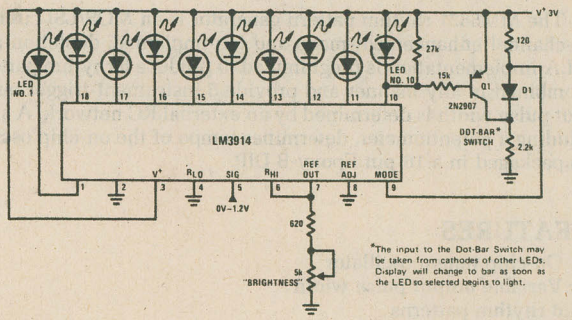
LM3914 (276-1707) LM3915 (276-1708)

Bar Display with Alarm Flasher



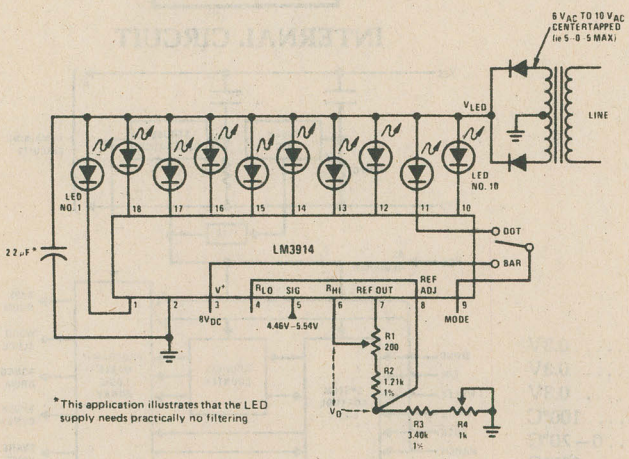
Full-scale causes the full bar display to flash. If the junction of R1 and C1 is connected to a different LED cathode, the display will flash when that LED lights, and at any higher input signal.

Indicator and Alarm



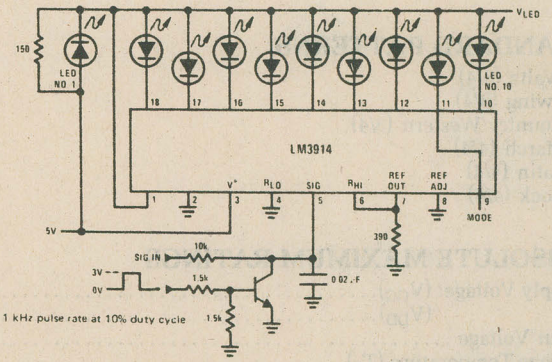
*The input to the Dot-Bar Switch may be taken from cathodes of other LEDs. Display will change to bar as soon as the LED so selected begins to light.

Expanded Scale Meter, Dot or Bar



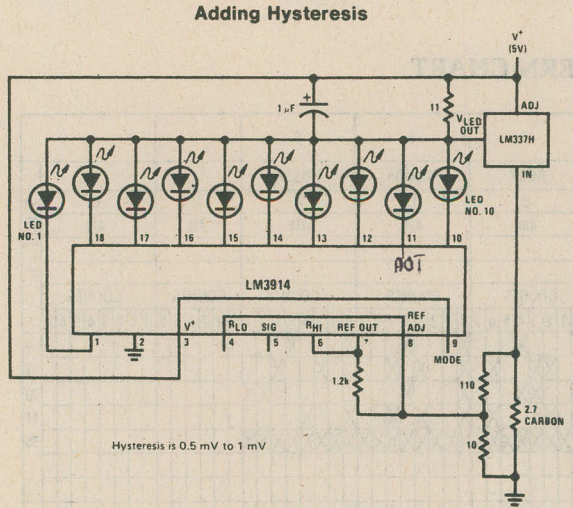
*This application illustrates that the LED supply needs practically no filtering

Exclamation Point Display



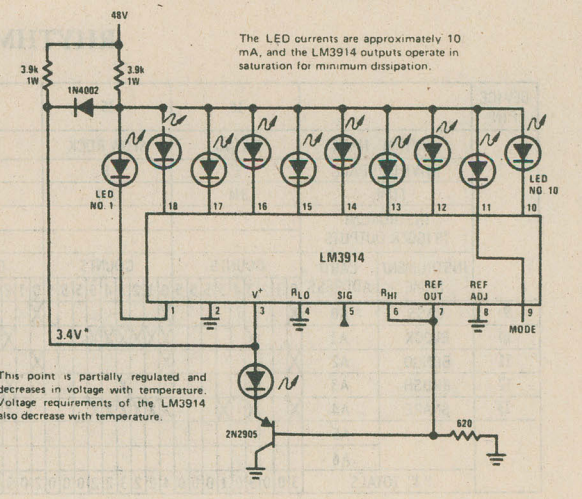
1 kHz pulse rate at 10% duty cycle

Adding Hysteresis



Hysteresis is 0.5 mV to 1 mV

Operating with a High Voltage Supply

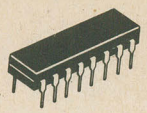


The LED currents are approximately 10 mA, and the LM3914 outputs operate in saturation for minimum dissipation.

*This point is partially regulated and decreases in voltage with temperature. Voltage requirements of the LM3914 also decrease with temperature.

MM5871 RHYTHM PATTERN GENERATOR

276-1785



GENERAL DESCRIPTION

The MM5871 rhythm pattern generator is an MOS/LSI circuit, fabricated with P-channel enhancement-mode and ion-implanted, depletion-mode devices. The PLA implementation is programmed to produce 6 rhythm patterns which may be combined in any manner and provide 5 instrument-trigger outputs. Trigger output pulse width is determined by an external RC network. A similar network, including a potentiometer, determines tempo of the on-chip oscillator. This circuit is packaged in a 16-pin Epoxy-B DIP.

FEATURES

- On-chip tempo oscillator
- Variable output pulse width
- 6 rhythm patterns
- 5 trigger outputs
- Flexible supply voltages
- Low power dissipation

APPLICATIONS

- Electronic organs
- Portable rhythm boxes

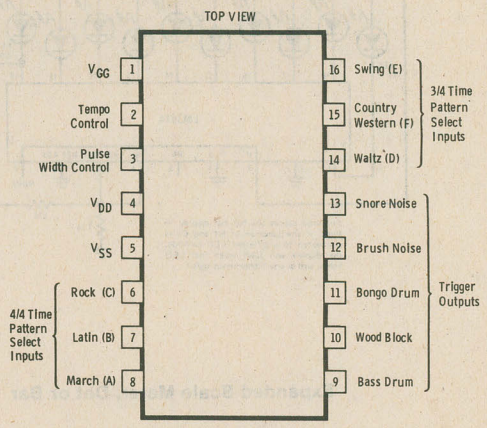
STANDARD PATTERNS

- Waltz (3/4)
- Swing (3/4)
- Country/Western (3/4)
- March (4/4)
- Latin (4/4)
- Rock (4/4)

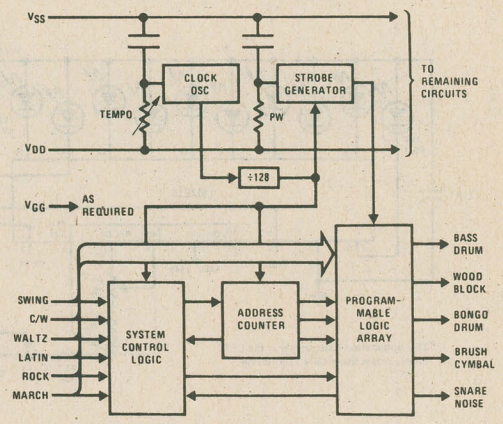
ABSOLUTE MAXIMUM RATINGS

Supply Voltage: (V_{GG}) 0.3V
(V_{DD}) 0.3V
Input Voltage 0.3V
Storage Temperature (T_S) ..... 100°C
Operating Temperature (T_A) ..... 0—70°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

PIN CONNECTION



INTERNAL CIRCUIT

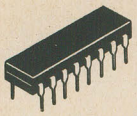


RHYTHM PATTERN CHART

DEVICE PIN			16	15	14	7	6	8			
	RHYTHM NAME		SWING	SLOW ROCK	WALTZ	ROCK	SAMBA	BOSSA			
	RHYTHM SPACE		E	F	D	B	C	A	H	G	
	TIME		3/4	3/4	3/4	4/4	4/4	4/4	3/4	4/4	
	INSTRUMENT TRIGGER OUTPUTS										
	INSTRUMENT NAME	CARD ADDRESS	COUNTS	COUNTS	COUNTS	COUNTS	COUNTS	COUNTS	COUNTS	COUNTS	"1" TOTALS
			0 1 2 3 4 5 5 5 5	0 1 2 3 4 5 5 5 5	0 1 2 3 4 5 5 5 5	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5	0 1 2 3 4 5 6 7	
9	BASS	A0	X	X	X	X	X	X			9
10	BLOCK	A1	X	X	X	X	X	X			17
11	BONGO	A2	X	X	X	X	X	X			10
12	BRUSH	A3	X	X	X	X	X	X			11
13	SNARE	A4	X	X	X	X	X	X			35
		A5									
		A6									
	"1" TOTALS		3 0 0 3 0 1 0 0 0	4 2 2 3 2 2 0 0 0	2 0 3 0 3 0 0 0 0	3 1 3 3 3 1 3 1 5	1 1 3 3 3 1 1 3 1	2 2 2 2 2 2 2			82

$8.95

P. 125



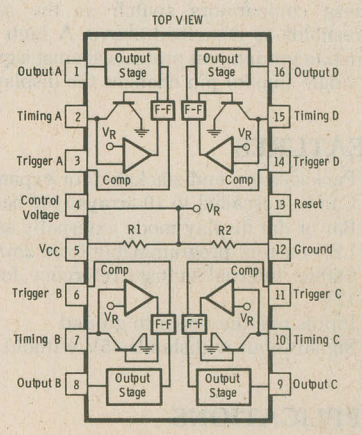
QUAD TIMER NE558
276-1742

GENERAL DESCRIPTION

The NE558 Quad Timer is a monolithic timing device which can be used to produce four entirely independent timing functions. The 558 output sinks current. These highly stable, general purpose controllers can be used in a monostable mode to produce accurate time delays, from microseconds to hours. In the time delay mode of operation, the time is precisely controlled by one external resistor and one capacitor. A stable operation can be achieved by using two of the four timer sections.

The four timing sections in the 558 are edge triggered; therefore, when connected in tandem for sequential timing applications, no coupling capacitors are required.

PIN CONNECTION



FEATURES

- 100mA output current per section
- Edge triggered (no coupling capacitor)
- Output independent of trigger conditions
- Wide supply voltage range 4.5V to 16V
- Timer intervals from microseconds to hours

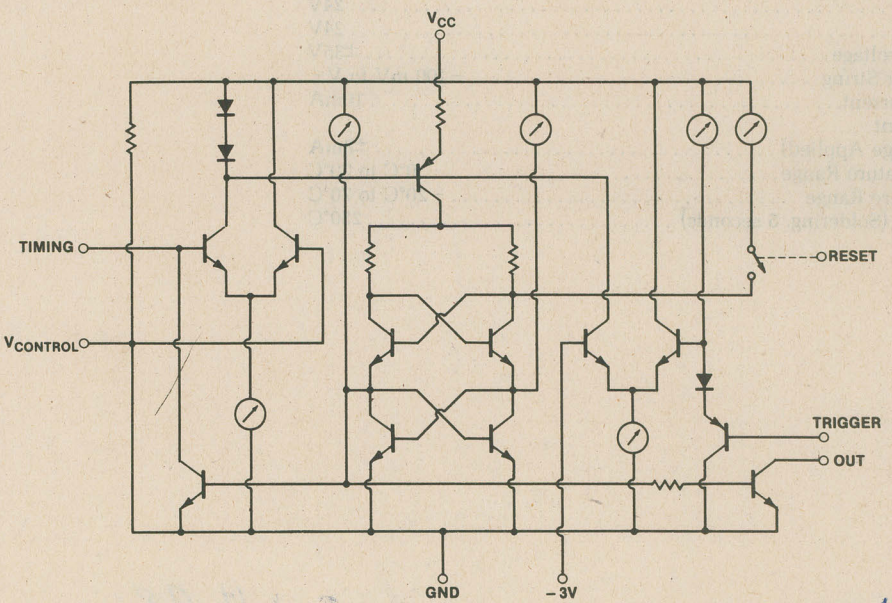
APPLICATIONS

- Sequential timing
- Time delay generation
- Precision timing
- Industrial controls
- Quad one-shot

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+16V
Power Dissipation	1.25W
Operating Temperature Range	0 to +70°C
Storage Temperature Range	−65 to +150°C
Lead Temperature (Soldering, 60sec)	+300°C

INTERNAL SCHEMATIC



$ 299

P.126

NSM3916 LED VU METER MODULE

277-1009

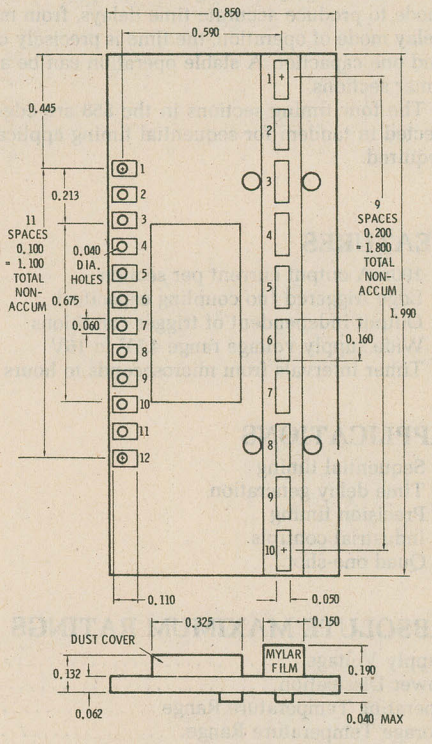
GENERAL DESCRIPTION

The NSM3900 series are functional replacements for a variety of conventional meters. Each combines a 10-element red LED linear array and a monolithic integrated circuit display driver. The driver circuits, similar to the LM3900 series, light successive LEDs as the analog input voltage level increases past prescaled threshold points.

The NSM3916 a variation of the logarithmic display; the VU meter function is provided by using threshold points to common VU levels.

The driver circuit contains a stable, adjustable voltage reference which precisely sets LED thresholds independently of supply voltage. Current drives to the LEDs are regulated and programmable, eliminating the need for many resistors. The entire display array can operate from supply voltages as low as 3V to as high as 24V. The internal voltage reference is also connected to an accurate 10-step voltage divider, supplying reference voltages for 10 individual comparators. These comparators switch as the signal voltage exceeds the established thresholds as described above. A high impedance input buffer accepts signals down to ground, yet protects against signal inputs of 35V above or below ground. A single (mode) pin changes the display from a bar graph to a moving dot.

PIN CONNECTION



FEATURES

- Packages are end-stackable for expanded displays
- Can be cascaded to 10 arrays (100 bar graph element)
- Bar or dot display mode externally selectable by user
- LED current programmable from 2mA to 30mA
- Stable, internal voltage reference for full-scale analog inputs from 1.2V to 12V
- Inputs operate down to ground
- Signal input withstands 35V without damage or false outputs

APPLICATIONS

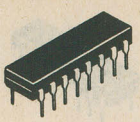
- VU meter in tape recorders
- Process control meters
- Replacement for edge meters
- VU meter in audio consoles

ABSOLUTE MAXIMUM RATINGS

Power Dissipation-Driver	500mW
V+ Voltage	24V
V_{LED} Voltage	24V
Input Signal Overvoltage	±35V
Voltage on Resistor String	−100 mV to V+
Reference Load Current	10mA
Single Input Current (With Overvoltage Applied)	±3mA
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	−20°C to 70°C
Lead Temperature (Soldering, 5 seconds)	230°C

11.95

P. 12a



TOP OCTAVE SYNTHESIZER

S50240P
276-1780

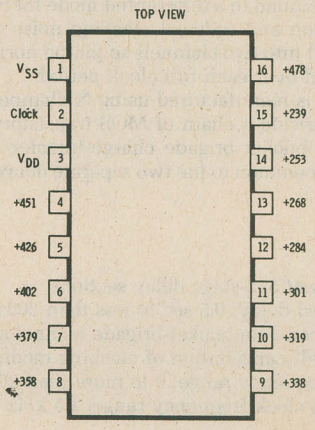
GENERAL DESCRIPTION

The S50240P is one of a family of ion-implanted, P-channel MOS, synchronous frequency dividers. Each output frequency is related to the others by a multiple $12\sqrt{2}$ providing a full octave plus one note on the equal tempered scale. Low threshold voltage enhancement-mode, as well as depletion mode devices, are fabricated on the same chip allowing the S5024 family to operate from a single, wide tolerance supply. Depletion-mode technology also allows the entire circuit to operate on less than 360-mW of power. The circuits are packaged in 16 pin plastic dual-in-line packaes. RFI emination and teed-through are minimized by placing the input clock between the V_{DD} and V_{SS} pins. Internally the layout of the chip isolates the output buffer circuitry from the divisor circuit clock lines. Also, the output buffers limit the minimum rise time under no load conditions to reduce the R. F. harmonic content of each output signal.

FEATURES

- Single power supply
- Broad supply voltage operating range
- Low power dissipation
- High output drive capability
- S50240—50% output duty cycle

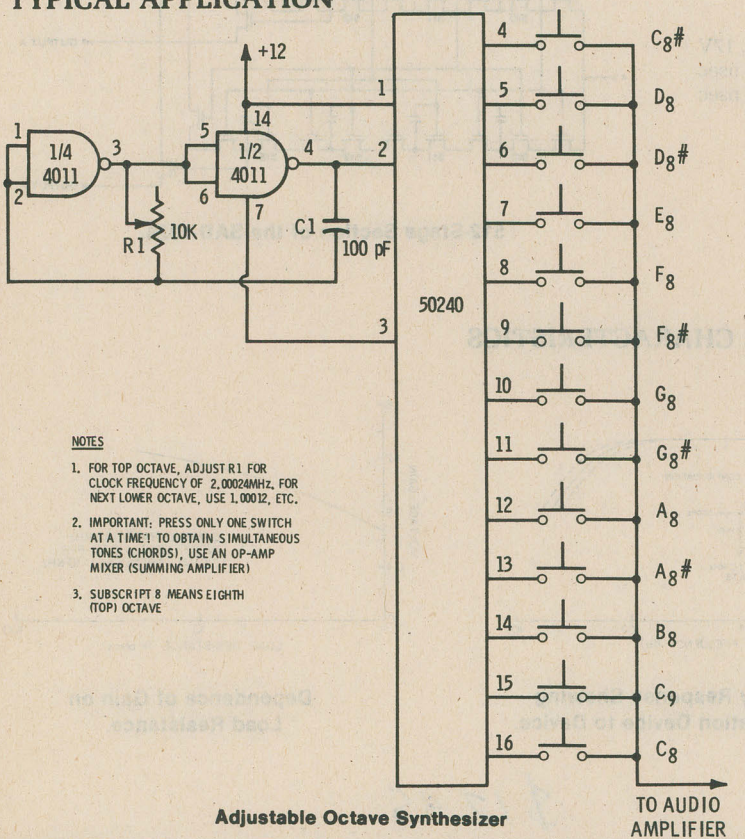
PIN CONNECTION



ABSOLUTE MAXIMUM RATINGS

Voltage on Any Pin Relative to V_{SS} ..... +0.3V to −20V
Operating Temperature (Ambient) ..... 0°C to 50°C
Storage Temperature (Ambient) ..... −65°C to +150°C

TYPICAL APPLICATION

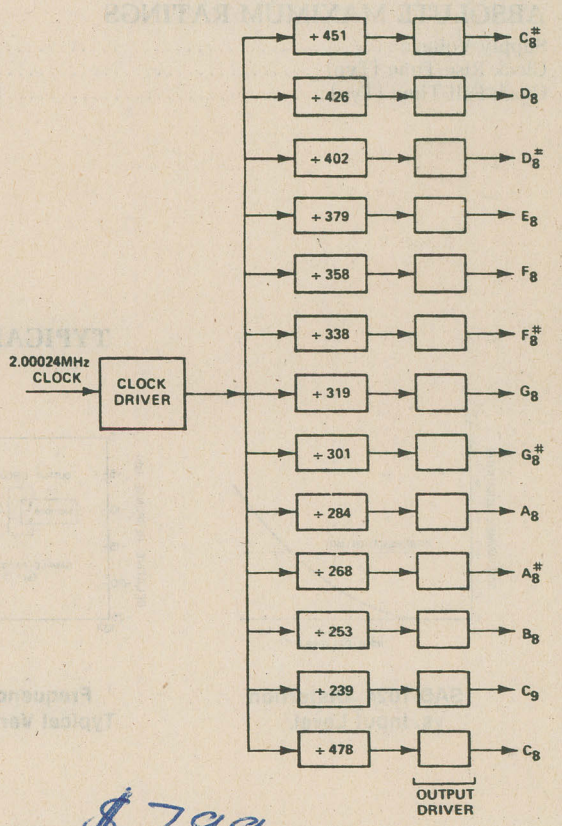


NOTES

1. FOR TOP OCTAVE, ADJUST R1 FOR CLOCK FREQUENCY OF 2.00024MHz. FOR NEXT LOWER OCTAVE, USE 1.00012, ETC.
2. IMPORTANT: PRESS ONLY ONE SWITCH AT A TIME! TO OBTAIN SIMULTANEOUS TONES (CHORDS), USE AN OP-AMP MIXER (SUMMING AMPLIFIER)
3. SUBSCRIPT 8 MEANS EIGHTH (TOP) OCTAVE

Adjustable Octave Synthesizer

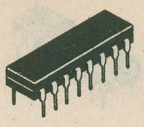
INTERNAL CIRCUIT



$7.99
P. 125

SAD-1024 DUAL ANALOG DELAY LINE

276-1761



GENERAL DESCRIPTION

The SAD-1024 is a dual 512-stage Bucket-Brigade Device (BBD). Each 512-stage section is independent as to input, output, and clock. The sections may be used independently, may be multiplexed to give an increased effective sample rate, may be connected in series to give increased delay at a fixed sample rate, or may be operated in a differential mode for reduced even-harmonic distortion and reduced clocking noise. Each section has its output split into two channels so that in normal operation output is provided over each full clock period.

The SAD-1024 is manufactured using N-channel silicon-gate technology to fabricate a chain of MOS transistors and storage capacitors into a bucket brigade charge-transfer device. Only V_{dd} and GND are common to the two separate delay sections.

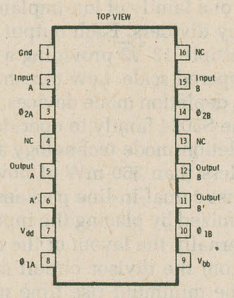
FEATURES

- Two independent 512-stage delay sections.
- Clock-controlled delay: 0.5 sec to less than 200 μsec.
- N-channel silicon-gate bucket-brigade technology.
- Designed for self-cancellation of clocking modulation.
- Wide signal-frequency range: 0 to more than 200 kHz.
- Wide sampling clock frequency range: 1.5 kHz to more than 1.5 MHz.
- Wide dynamic range: S/N > 70 db.
- Low distortion: less than 1%
- Low noise: typically limited by output amplifier.
- Single 15 volt power supply.

ABSOLUTE MAXIMUM RATINGS

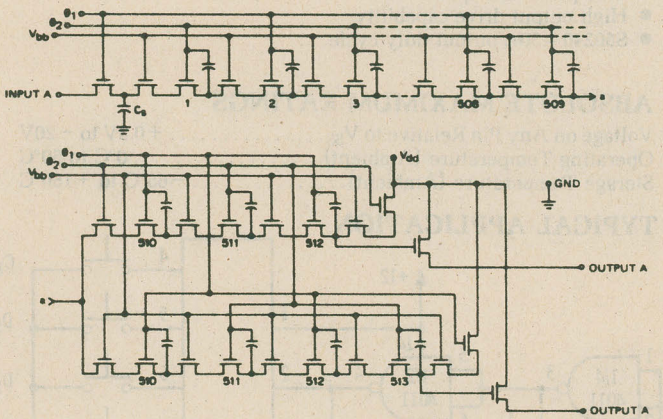
Supply Voltage	17V
Clock Rise Time (Typ)	3 nsec
Clock Fall Time (Typ)	5 nsec

PIN CONNECTION



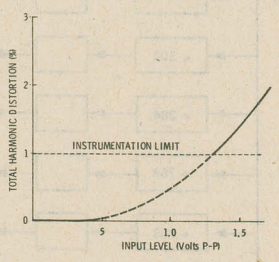
Unused outputs should be connected to Vdd, all other unused pins should be connected to Gnd (pin 1). Including those marked NC

INTERNAL CIRCUIT

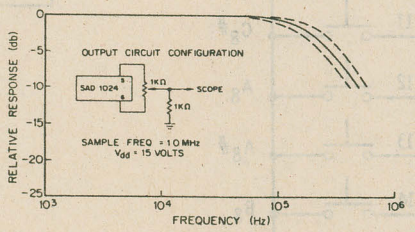


512-Stage Section of the SAD-1024.

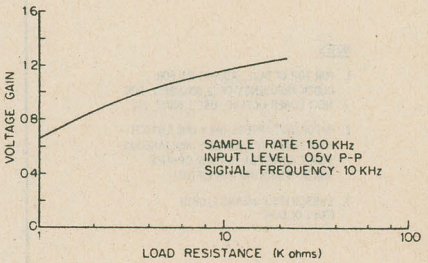
TYPICAL CHARACTERISTICS



SAD-1024 Distortion vs. Input Level.



Frequency Response Showing Typical Variation Device to Device.



Dependence of Gain on Load Resistance.

$12.95

P. 125

COMPLEX SOUND GENERATOR

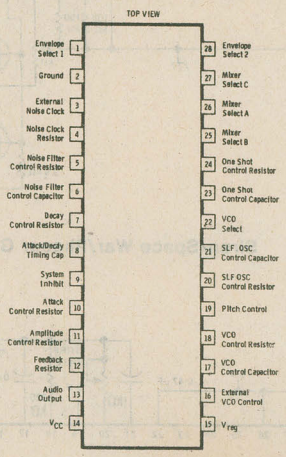
SN76477
276-1765
SN76488
276-1766

GENERAL DESCRIPTION

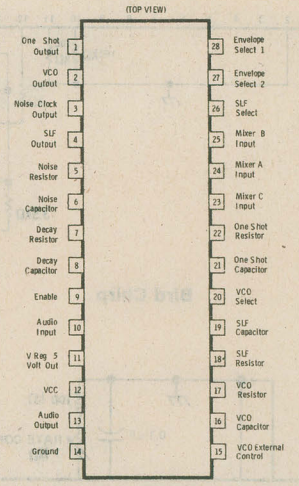
The SN76477 and SN76488 complex sound generators are monolithic chips combining both analog (bipolar) and digital (I^2L) circuitry. They each include a noise oscillator (VOC), and a super-low frequency oscillator (SLF) together with a noise filter, mixer, attack/decay circuitry, audio amplifier, and control circuitry to provide noise, tone, or low-frequency sounds and any combinations of these. Programming is accomplished via control inputs and user-defined external components, which allows a wide variety of sounds to be created and tailored for particular applications. These devices may be used in a variety of applications requiring audio feedback to the operator including entertainment equipment such as arcade or home video games, pinball games, toys; consumer-oriented equipment such as timers, alarms, and controls; and industrial equipment for indicators, alarms, controls, etc.

Operation is either from a five-volt regulated supply applied to $V_{reg.}$ or from a 7.5-volt to 10-volt supply applied to a built-in voltage regulator through the V_{CC} terminal, in which case a regulated five volts is available from the V_{reg} terminal to power a small amount of external circuitry, or to provide a high-logic-level voltage to logic inputs. The SN76488 does not need an output amplifier.

PIN CONNECTION



SN76477



SN76488

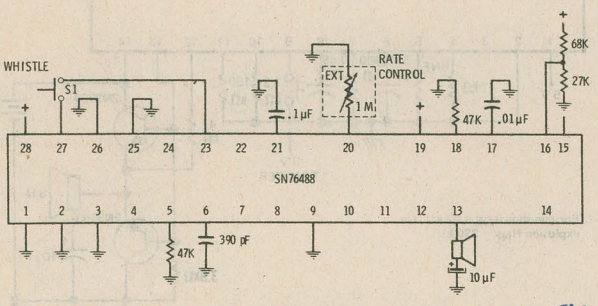
FEATURES

- Generates noise, tone, or low-frequency-based sounds, or combinations of these
- Sounds are defined by user via external components
- Allows custom sounds to be created easily
- Low power requirements
- Allows multiple-sound systems
- Compatible with microprocessor systems

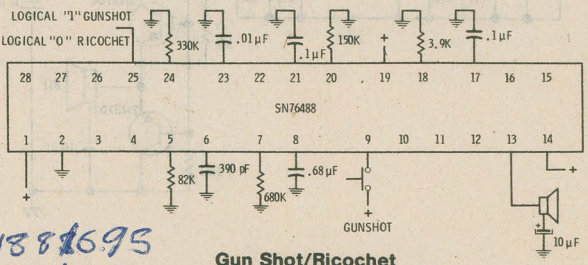
ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC} 15V
Supply Voltage V_{reg} 6
Input Voltage:
  Any Logic Input 12V
  Any Capacitor Input 5V
Oprating Free-Air Temperature Range ..... 0°C to 70°C
Storage Temperature Range ..... −65°C to 150°C
Lead Temperature 1/16 inch (1.6 mm)
  from Case for 10 Seconds ..... 260°C

TYPICAL APPLICATIONS



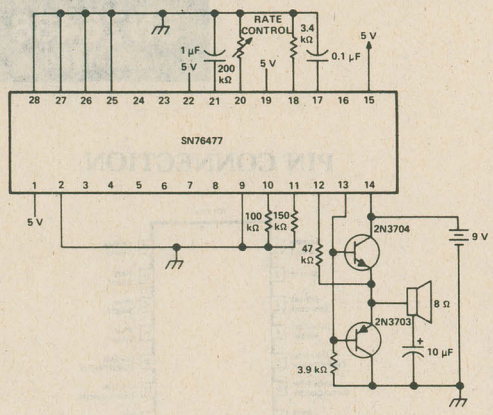
Steam Train with Whistle



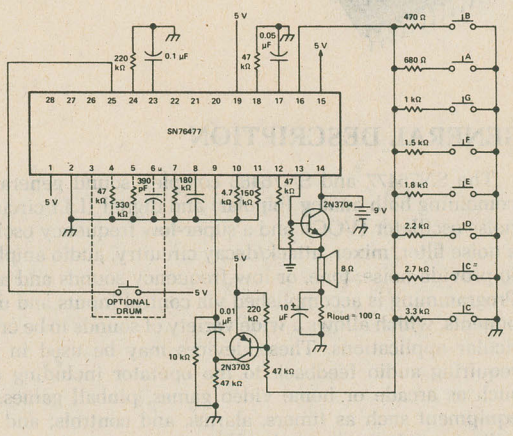
Gun Shot/Ricochet

SN76488695
SN76477499

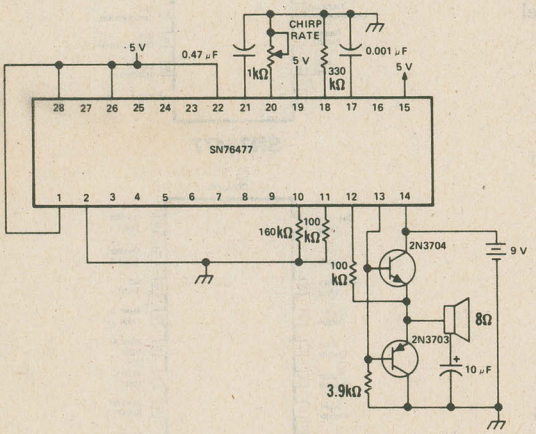
SN76477 (276-1765) SN76488 (276-1766)



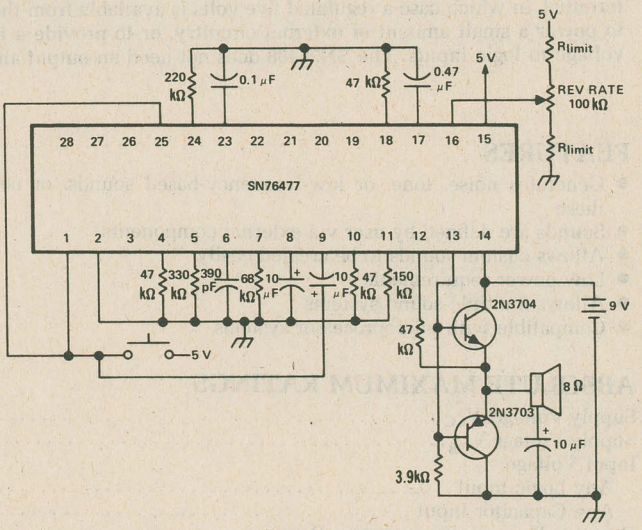
Siren/Space War/Phasor Gun



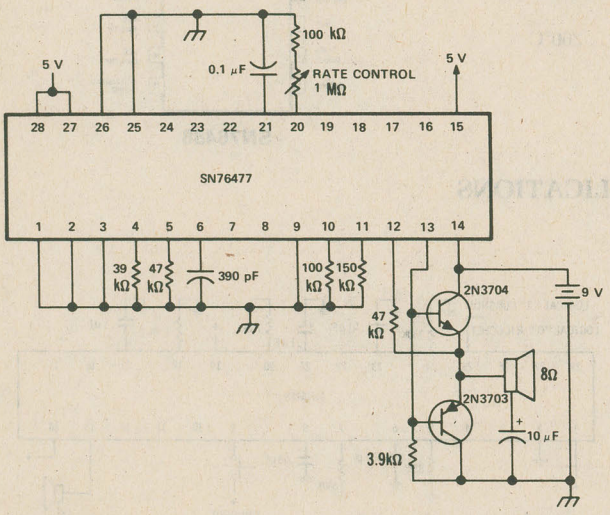
Musical Organ



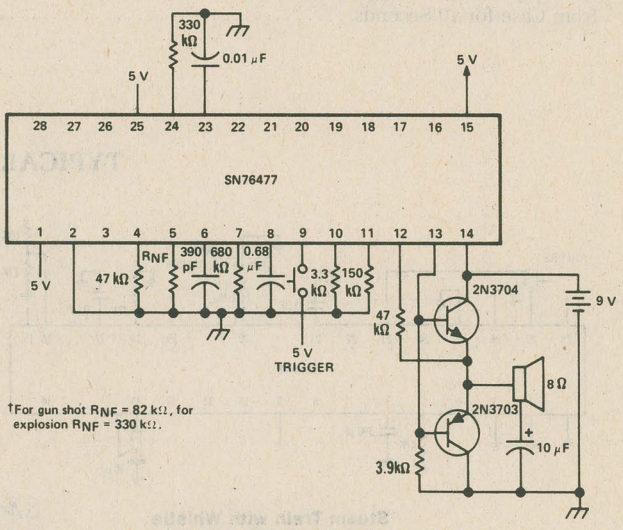
Bird Chirp



Race Car Motor/Crash



Steam Train/Prop Plane



†For gun shot R_{NF} = 82 kΩ, for explosion R_{NF} = 330 kΩ.

Gunshot/Explosion

5.8W AUDIO POWER AMPLIFIER

TA7205AP
276-705

GENERAL DESCRIPTION

The TA7205AP is a monolithic audio power amplifier with a built in thermal shut-down circuit. Design for car radio and stereo applications.

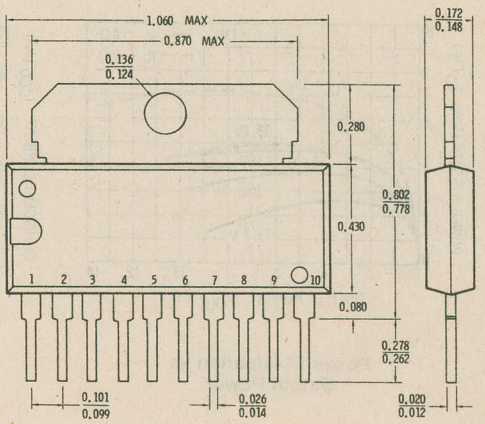
FEATURES

- Low distortion
  THD=0.15% (Typ.) ($@P_{OUT}$=1W, G_V=55dB)
  THD=0.07% (Typ.) ($@P_{OUT}$=1W, G_V=44dB)
- Operating supply voltage range: V_{CC}=9~18V
- 'PCT' process to insure low noise characteristic
- Current limiting for short-circuit protection
- Built in thermal shut-down circuit
- Built in surge voltage protection circuit

ABSOLUTE MAXIMUM RATINGS

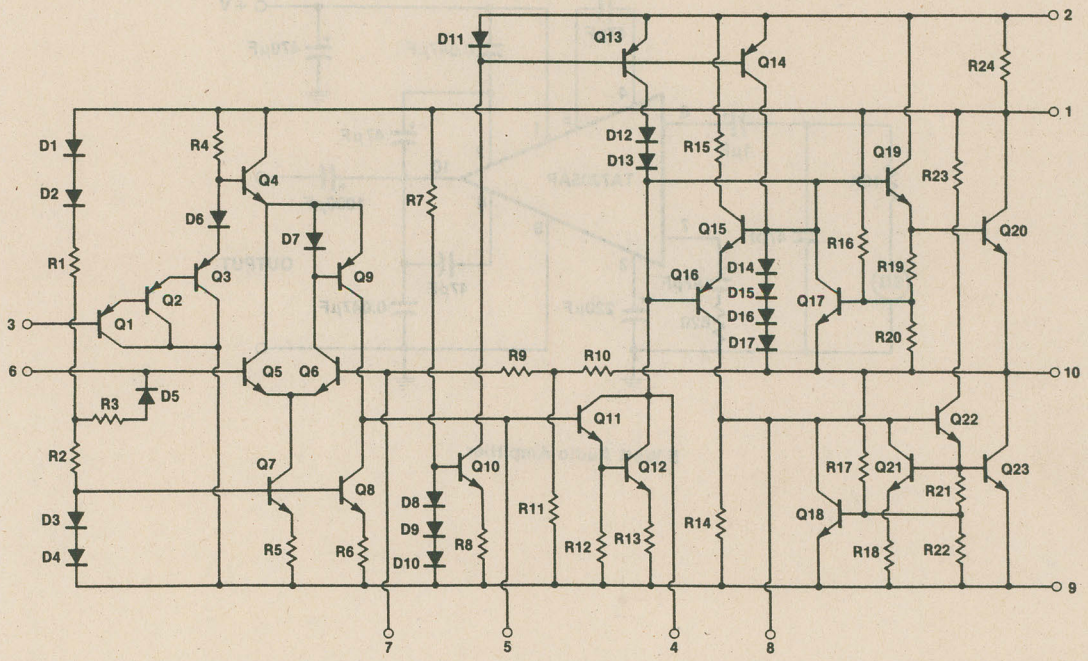
Operating Supply Voltage(V_{CC})	18V
Quiescent Supply Voltage (V_{CCQ})	25V
Output Peak Current (I_O)	4.5A
Quiescent Current (I_{CCQ})	80mA
Operating Temperature	−20 to 75°C
Storage Temperature	−55 to 150°C

PIN CONNECTION



PIN	FUNCTION
1	Vt
2	Bootstrap
3	Decoupling
4	Phase Compensation
5	Phase Compensation
6	Input
7	Negative Feedback
8	Phase Compensation
9	Ground
10	Output

INTERNAL CIRCUIT

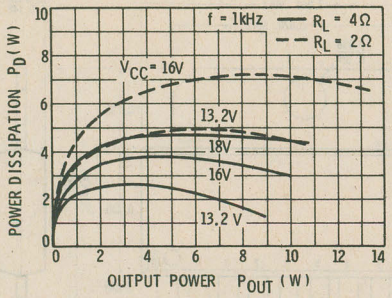


$3.49

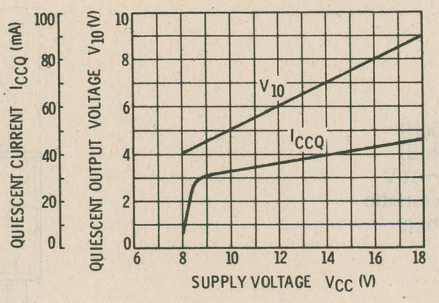
P.125

TA7205AP (276-705)

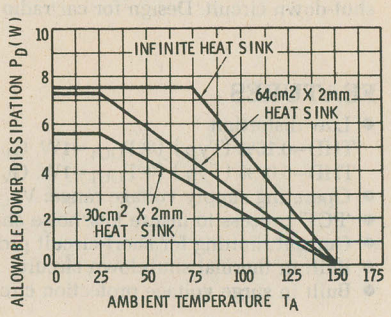
TYPICAL CHARACTERISTICS



Power Dissipation vs Output Power

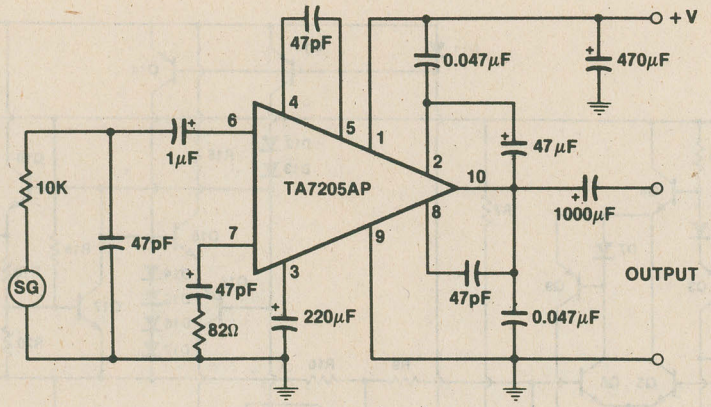


Quiescent current and Output Voltage vs Supply Voltage



Allowable Power Dissipation vs Ambient Temperature

TYPICAL APPLICATION



5 Watt Audio Amplifier

JFET-INPUT OPERATIONAL AMPLIFIER

TL081
276-1716

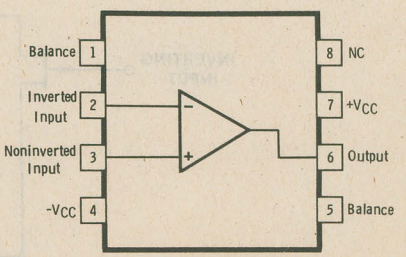
GENERAL DESCRIPTION

This monolithic JFET-input operational amplifier incorporates well-matched, high-voltage BI-FET technology (JFET's on the same chip with standard bipolar transistors). The device features low input bias and offset currents, low offset voltage and offset voltage temperature coefficient, coupled with offset adjustment that does not degrade temperature coefficient or common-mode rejection.

FEATURES

- JFET input stage
- High input impedance . . . $10^9\ \Omega$ Typ
- High slew rate typically $13V/\mu s$
- Low input bias current . . . 2nA Typ
- Low input offset current . . . 0.2nA Typ
- No frequency compensation required
- Continuous-short-circuit protection
- Unity gain bandwidth . . . 3 MH_Z Typ
- No latch-up
- Low power consumption

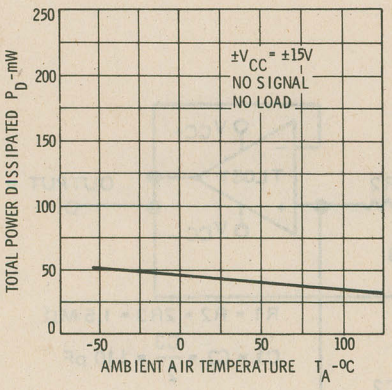
PIN CONNECTION



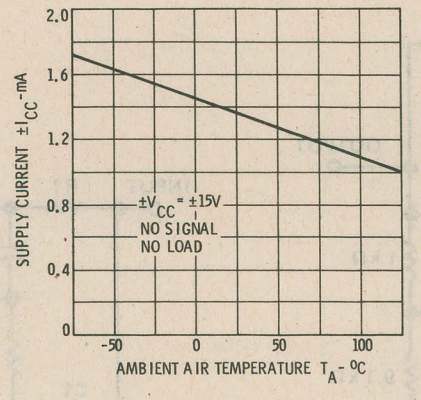
ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC+} 18V
Supply Voltage V_{CC-} . . . . . −18V
Differential Input Voltage . . . . . ±30V
Input Voltage . . . . . ±15V
Duration of Output Short-Circuit . . . . . unlimited
Continuous Total Dissipation at (or below) 25°C Free-Air Temperature. 670mW
Operating Free-Air Temperature Range . . . . . 0°C to 70°C
Storage Temperature Range . . . . . −65°C to 150°C
Lead Temperature 1/16 Inch From Case for 60 Seconds: JG Package . . . . . 300°C
Lead Temperature 1/16 Inch From Case for 10 Seconds: P Package . . . . . 260°C

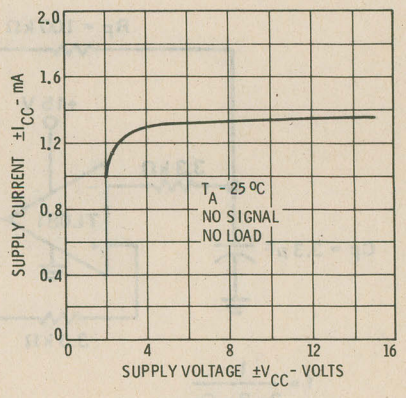
TYPICAL CHARACTERISTICS



Total Power Dissipated vs Free-Air Temperature



Supply Current vs Free-Air Temperature



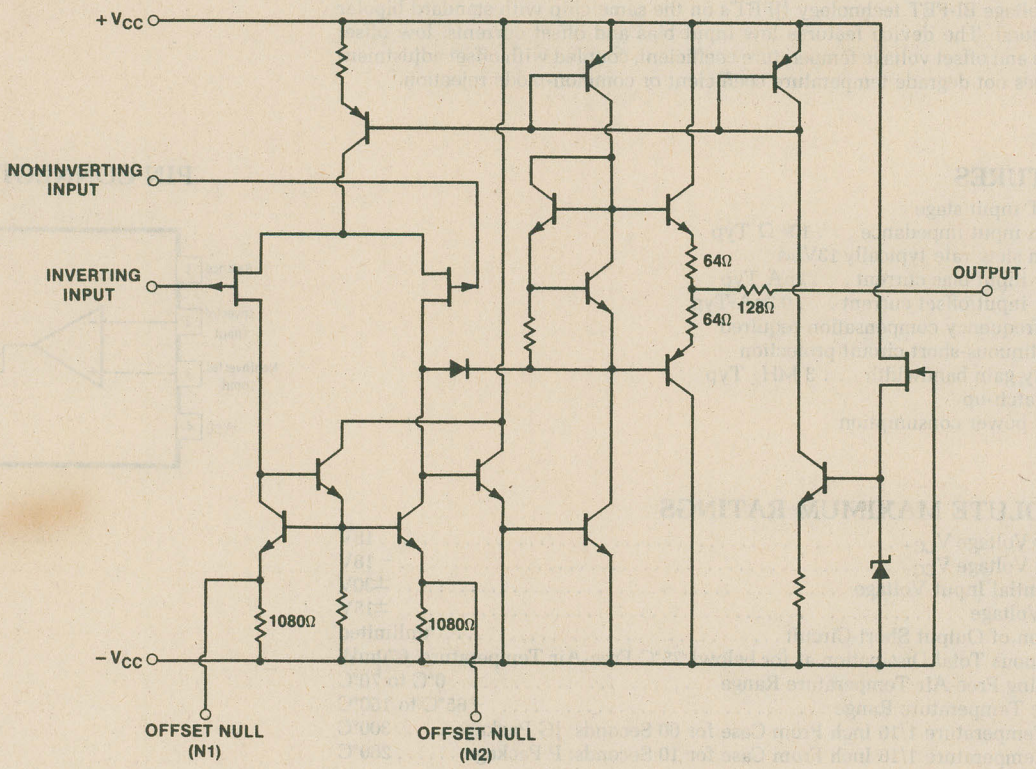
Supply Current vs Supply Voltage

$2.19

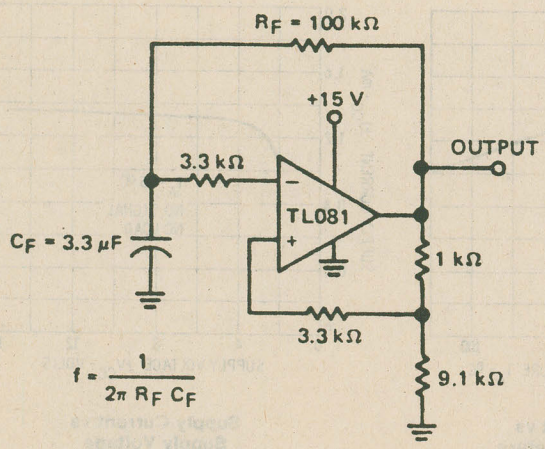
P.125

TL081 (276-1716)

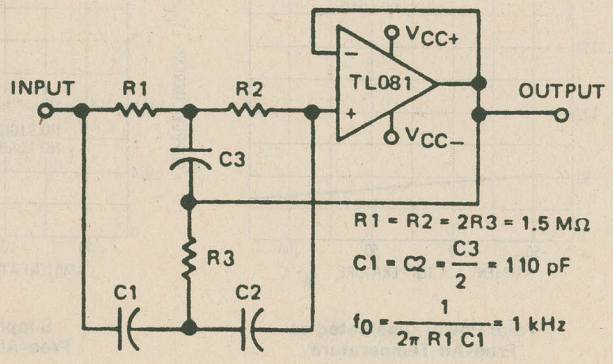
INTERNAL CIRCUIT



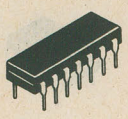
TYPICAL APPLICATIONS



0.5Hz Square-Wave Oscillator



High-Q Notch Filter



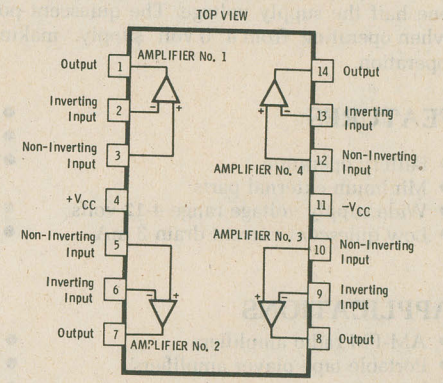
QUAD BI-FET OPERATIONAL AMPLIFIER

TL084CN
276-1714

GENERAL DESCRIPTION

The TL084 JFET-input operational amplifier is designed to offer better performance than any previously developed quad-operational amplifier. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

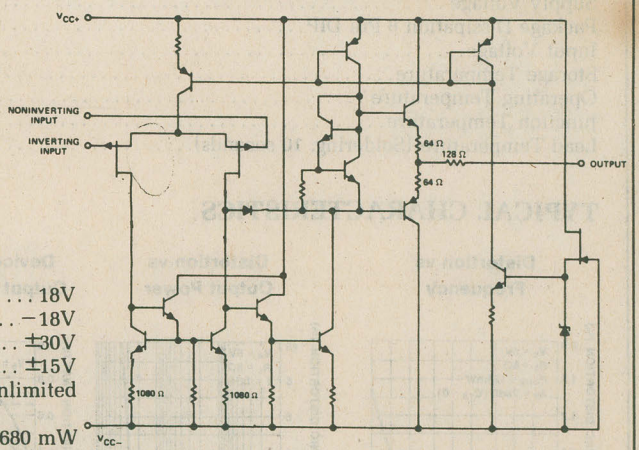
PIN CONNECTION



FEATURES

- Low power consumption
- Wide common-mode and differential voltage ranges
- Low input bias and offset currents
- Output short-circuit protection
- High input impedance—JFET-input stage
- Internal frequency compensation
- Latch-up-free operation
- High slew rate—13 V/μs Typ

INTERNAL CIRCUIT

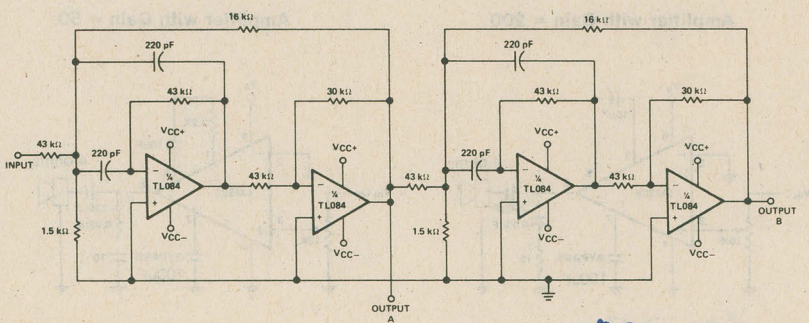


ABSOLUTE MAXIMUM RATINGS

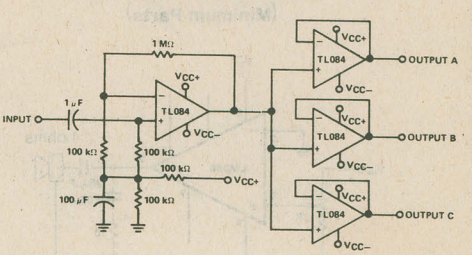
Supply Voltage, $V_{CC}+$	18V
Supply Voltage, $V_{CC}-$	−18V
Differential Input Voltage	±30V
Input Voltage	±15V
Duration of Output Short Circuit	Unlimited
Continuous Total Dissipation at (or Below) 25°C Free-Air Temperature	680 mW
Operating Free-Air Temperature Range	0 to 70°C
Storage Temperature Range	−65 to 150°C
Lead Temperature 1/16 inch from Case for 10 Seconds	260°C

TYPICAL APPLICATIONS

Positive—Feedback Bandpass Filter



Audio Distribution Amplifier



$3.99

A.125

LM386 LOW VOLTAGE AUDIO POWER AMPLIFIER

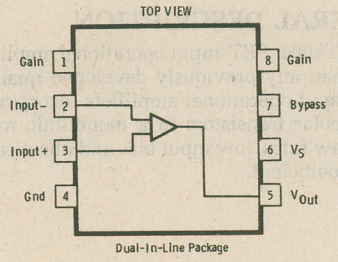
276-1731

GENERAL DESCRIPTION

The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value up to 200.

The inputs are ground referenced while the output is automatically biased to one half the supply voltage. The quiescent power drain is only 18 milli-watts when operating from a 6 volt supply, making the LM386 ideal for battery operation.

PIN CONNECTION



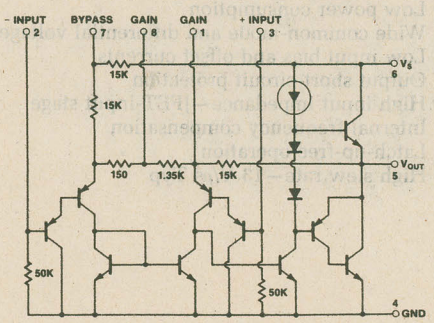
FEATURES

- Battery operation
- Minimum external parts
- Wide supply voltage range 4-12 volts
- Low quiescent current drain 3 mA
- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion
- Eight pin dual-in-line package

APPLICATIONS

- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

INTERNAL CIRCUIT

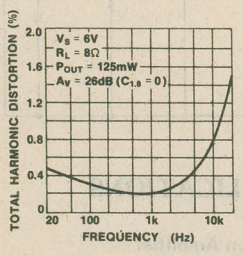


ABSOLUTE MAXIMUM RATINGS

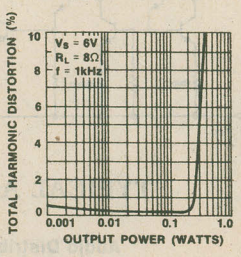
Supply Voltage	15V
Package Dissipation 8 Pin DIP	660 mW
Input Voltage	±0.4V
Storage Temperature	−65°C to +150°C
Operating Temperature	0°C to +70°C
Junction Temperature	+150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

TYPICAL CHARACTERISTICS

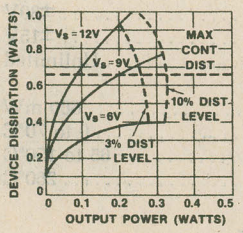
Distortion vs Frequency



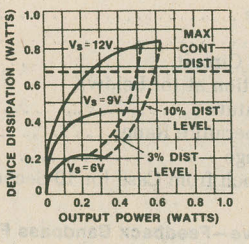
Distortion vs Output Power



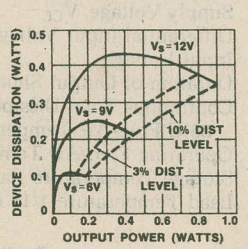
Device Dissipation vs Output Power—4Ω Load



Device Dissipation vs Output Power—8Ω Load

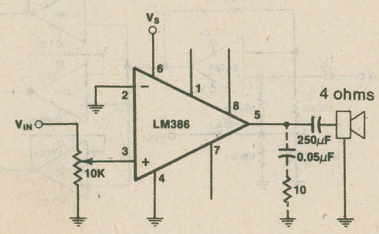


Device Dissipation vs Output Power—16Ω Load

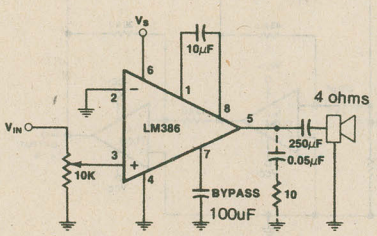


TYPICAL APPLICATIONS

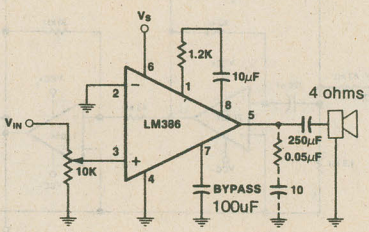
Amplifier with Gain = 20 (Minimum Parts)



Amplifier with Gain = 200

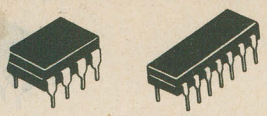


Amplifier with Gain = 50



$2.29

P-125



TIMER 555 278-1723
DUAL TIMER 556 276-1728

GENERAL DESCRIPTION

The 555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200 mA or drive TTL circuits. The 556 is a dual 555. The two timers operate independently of each other sharing only V_{CC} and ground.

FEATURES

- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C
- Normally on and normally off output

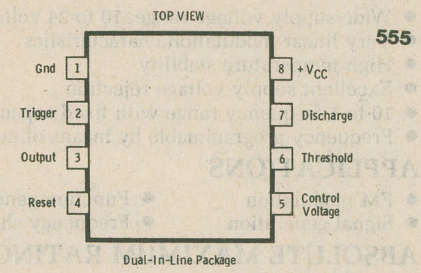
APPLICATIONS

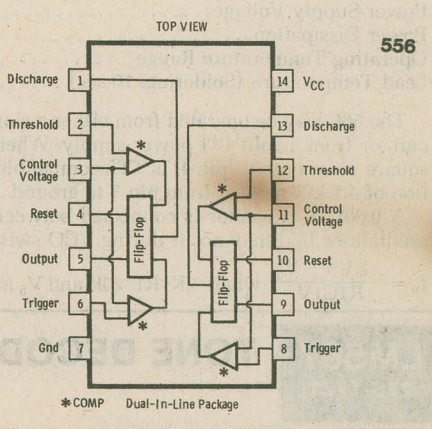
- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+16V
Power Dissipation	600 mW
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

PIN CONNECTION





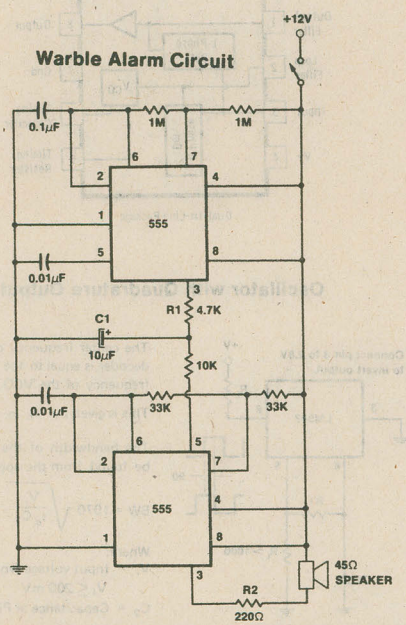
TYPICAL APPLICATIONS

TRUTH TABLE (IC555)

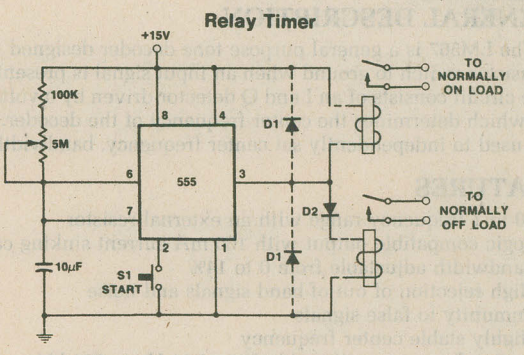
PIN 2 TRIGGER	PIN 6 THRESHOLD	PIN 4 RESET	PIN 3 OUTPUT
H	X	H	L
L	X	H	H
H	L	H	L
X	X	L	L

X = Don't Care L = Low Level H = High Level

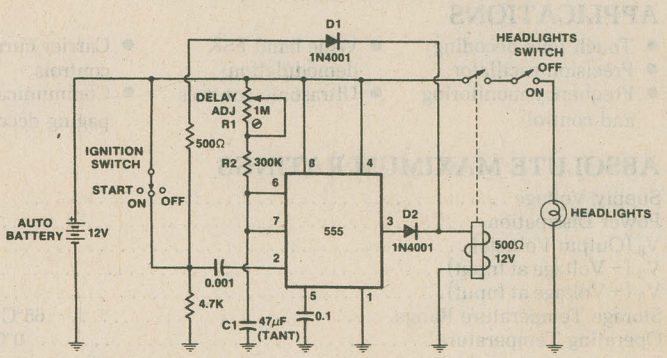
Warble Alarm Circuit



Relay Timer



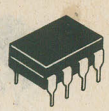
Automatic Headlight Turn-Off Circuit



$2.39
$3.89

P.126

LM566 276-1724 VOLTAGE CONTROLLED OSCILLATOR



GENERAL DESCRIPTION

The LM566 is a general purpose voltage controlled oscillator which may be used to generate square and triangular waves, the frequency of which is a very linear function of a control voltage. The frequency is also a function of an external resistor and capacitor.

FEATURES

- Wide supply voltage range: 10 to 24 volts
- Very linear modulation characteristics
- High temperature stability
- Excellent supply voltage rejection
- 10 to 1 frequency range with fixed capacitor
- Frequency programmable by means of current, voltage, resistor or capacitor.

APPLICATIONS

- FM modulation
- Function generation
- Tone generation
- Signal generation
- Frequency shift keying

ABSOLUTE MAXIMUM RATINGS

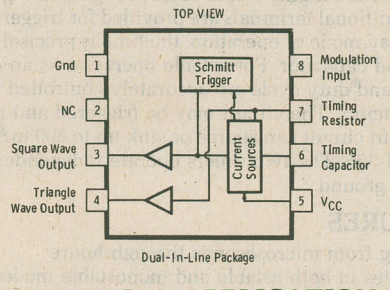
Power Supply Voltage 26V
Power Dissipation ..... 300 mW
Operating Temperature Range ..... 0°C to 70°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

The 566 may be operated from either a single supply as shown in this test circuit, or from a split (±) power supply. When operating from a split supply, the square wave output (pin 4) is TTL compatible (2 mA current sink) with the addition of 4.7 kΩ resistor from pin 3 to ground.

A 0.001 μF capacitor is connected between pins 5 and 6 to prevent parasitic oscillations that may occur during VCO switching.

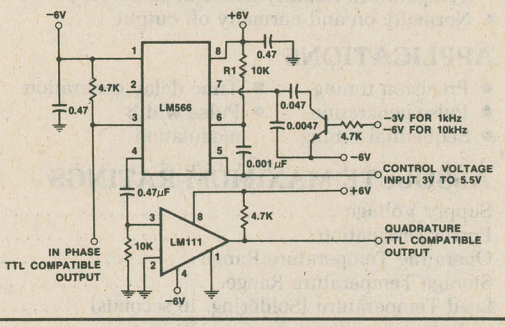
$f_o = \frac{2\,V^+ - V_5}{R1C1V^+}$ where 2K<R1<20K and V_5 is voltage between pin 5 and pin 1.

PIN CONNECTION



TYPICAL APPLICATION

1kHz And 10kHz TTL Compatible Voltage Controlled Oscillator



LM567 276-1721 TONE DECODER

GENERAL DESCRIPTION

The LM567 is a general purpose tone decoder designed to provide a saturated transistor switch to ground when an input signal is present within the passband. The circuit consists of an I and Q detector driven by a voltage controlled oscillator which determines the center frequency of the decoder. External components are used to independently set center frequency, bandwidth and output delay.

FEATURES

- 20 to 1 frequency range with an external resistor
- Logic compatible output with 100 mA current sinking capability
- Bandwidth adjustable from 0 to 14%
- High rejection of out of band signals and noise
- Immunity to false signals
- Highly stable center frequency
- Center frequency adjustable from 0.01 Hz to 500 kHz

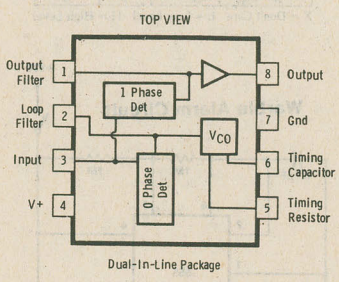
APPLICATIONS

- Touch tone decoding
- Precision oscillator
- Frequency monitoring and control
- Wide band FSK demodulation
- Ultrasonic controls
- Carrier current remote controls
- Communications paging decoders

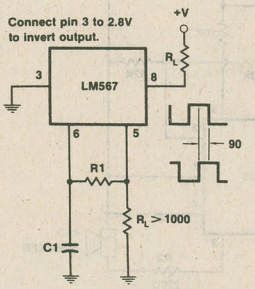
ABSOLUTE MAXIMUM RATINGS

Supply Voltage 9V
Power Dissipation ..... 300 mW
V_8 (Output Voltage) 15V
V_3 (−Voltage at Input) ..... −10V
V_3 (+Voltage at Input) ..... V_8 +0.5V
Storage Temperature Range ..... −65°C to +150°C
Operating Temperature ..... 0°C to +70°C

PIN CONNECTION



Oscillator with Quadrature Output



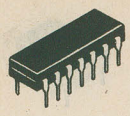
The center frequency of the tone decoder is equal to the free running frequency of the VCO.

This is given by $f_o \cong \frac{1}{R_1 C_1}$

The bandwidth of the filter may be found from the approximation

$BW = 1070\sqrt{\frac{V_i}{f_o C_2}}$ in % of f_o

Where:
V_i = Input voltage (volts rms), $V_i \leq 200$ mV
C_2 = Capacitance at Pin 2 (μF)



ADJUSTABLE VOLTAGE REGULATOR

723
276-1740

GENERAL DESCRIPTION

The 723 is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain, and provision is made for either linear or foldback current limiting.

FEATURES

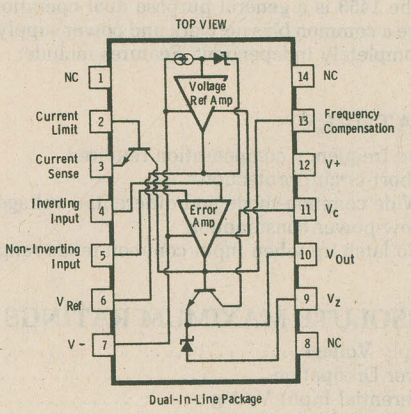
- 150 mA output current without external pass transistor
- Output currents in excess of 10A possible by adding external transistors
- Input voltage 40V max
- Output voltage adjustable from 2V to 37V
- Can be used as either a linear or a switching regulator

The 723 is also useful in a wide range of other applications such as a shunt regulator, a current regulator or a temperature controller.

ABSOLUTE MAXIMUM RATINGS

Pulse Voltage from V+ to V− (50 ms)	50V
Continuous Voltage from V+ to V−	40V
Input-Output Voltage Differential	40V
Maximum Amplifier Input Voltage (Either Input)	7.5V
Maximum Amplifier Input Voltage (Differential)	5V
Current from V_Z	25 mA
Current from V_{REF}	15 mA
Internal Power Dissipation Metal Can	800 mW
Cavity DIP	900 mW
Molded DIP	660 mW
Operating Temperature Range	0°C to +70°C
Storage Temperature Range Metal Can	−65°C to +150°C
DIP	−55°C to +125°C
Lead Temperature (Soldering, 10 sec)	300°C

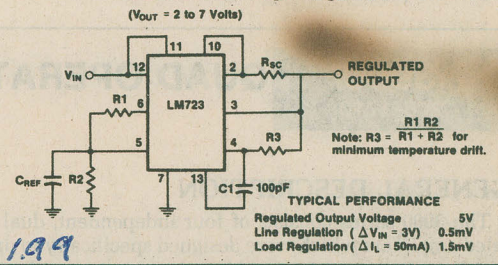
PIN CONNECTION



Dual-In-Line Package

TYPICAL APPLICATION

Basic Low Voltage Regulator



1.99

OPERATIONAL AMPLIFIER

741
276-007

GENERAL DESCRIPTION

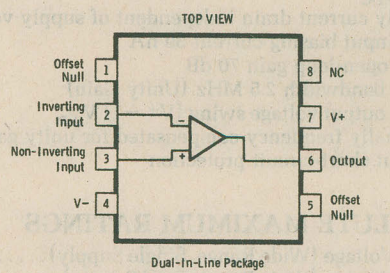
The 741 series are general purpose operational amplifiers which feature improved performance over industry standards.

The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±16V
Power Dissipation	500 mW
Differential Input Voltage	±30V
Input Voltage	±15V
Output Short Circuit Duration	Indefinite
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

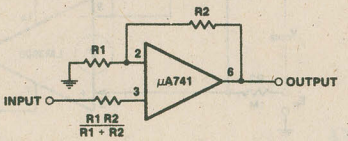
PIN CONNECTION



Dual-In-Line Package

TYPICAL APPLICATION

Non-Inverting Amplifier



GAIN	R1	R2	B.W.	R_{IN}
10	1K	9K	100kHz	400M
100	100Ω	9.9K	10kHz	280M
1000	100Ω	99.9K	1kHz	80M

1.79

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1458
276-038

DUAL OPERATIONAL AMPLIFIER

GENERAL DESCRIPTION

The 1458 is a general purpose dual operational amplifier. The two amplifiers share a common bias network and power supply leads. Otherwise, their operation is completely independent. Features include:

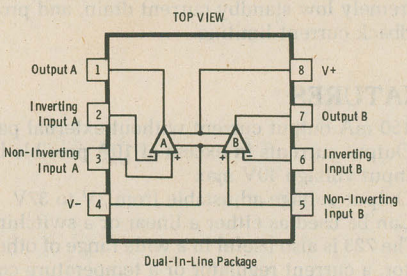
FEATURES

- No frequency compensation required.
- Short-circuit protection
- Wide common-mode and differential voltage ranges
- Low-power consumption
- No latch up when input common mode range is exceeded

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±16V
Power Dissipation	400 mW
Differential Input Voltage	±30V
Input Voltage	±15V
Output Short-Circuit Duration	Indefinite
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	−65°C to 150°C
Lead Temperature (Soldering, 10 sec)	300°C

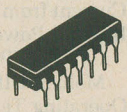
PIN CONNECTION



$1.99 P.125

3900
276-1713

QUAD OPERATIONAL NORTON AMPLIFIER



GENERAL DESCRIPTION

The 3900 series consists of four independent, dual input, internally compensated amplifiers which were designed specifically to operate off of a single power supply voltage and to provide a large output voltage swing. These amplifiers make use of a current mirror to achieve the non-inverting input function. Application areas include: ac amplifiers, RC active filters, low frequency triangle, squarewave and pulse waveform generation circuits, tachometers and low speed, high voltage digital logic gates.

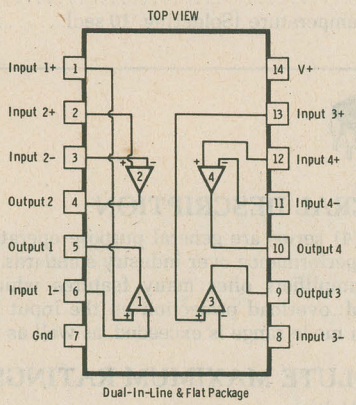
FEATURES

- Wide single supply voltage 4 V_{DC} to 36 V_{DC} range or dual supplies ±2 V_{DC} to ±18 V_{DC}
- Supply current drain independent of supply voltage
- Low input biasing current 30 nA
- High open-loop gain 70 dB
- Wide bandwidth 2.5 MHz (Unity Gain)
- Large output voltage swing $(V^+ - 1)$ $V_{p\text{-}p}$
- Internally frequency compensated for unity gain
- Output short-circuit protection

ABSOLUTE MAXIMUM RATINGS

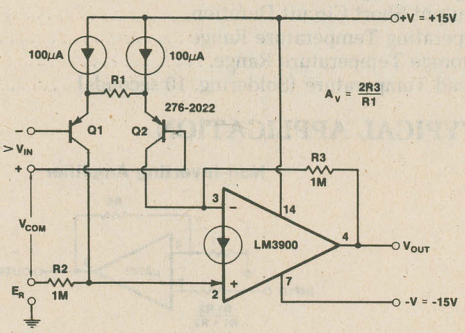
Supply Voltage (Wide Range, Single Supply)	32 V_{DC}
Supply Voltage (Wide Range, Dual Supply)	±16 V_{DC}
Power Dissipation (T_A = 25°C)	
Flat Pack	570 mW
Input Currents, I_{IN}^+ or I_{IN}^-	20 mA_{DC}
Output Short-Circuit Duration—One Amplifier	Continuous
T_A = 25°C (See Application Hints)	
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

PIN CONNECTION



TYPICAL APPLICATIONS

Basic Instrumentation Amplifier



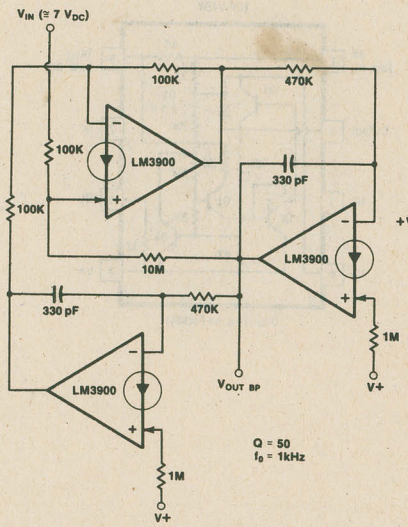
$1.99 ea

P.125

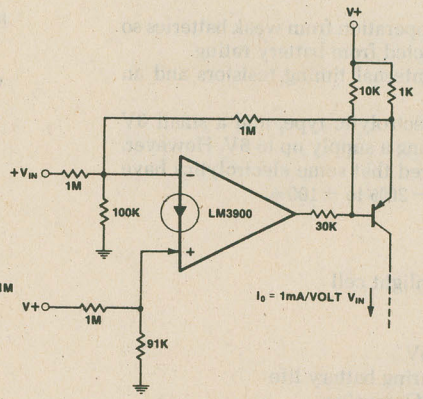
3900 (276-1713)

TYPICAL APPLICATIONS (Con't)

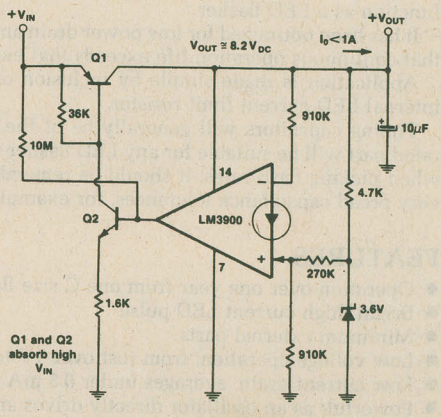
Bi-Quad Active Filter (2nd Degree State-Variable Network)



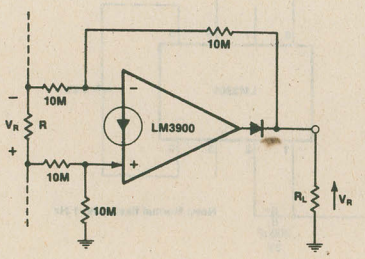
Voltage Controlled Current Source (Transconductance Amplifier)



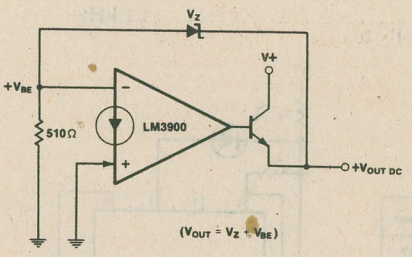
High V_{IN}, Low (V_{IN} − V_{OUT}) Self Regulator



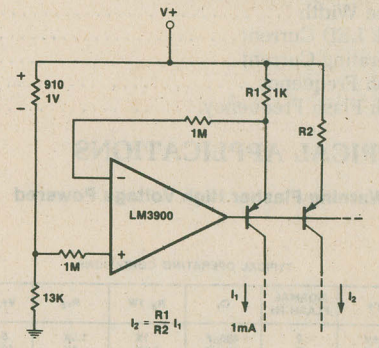
Ground-Referencing a Differential Input Signal



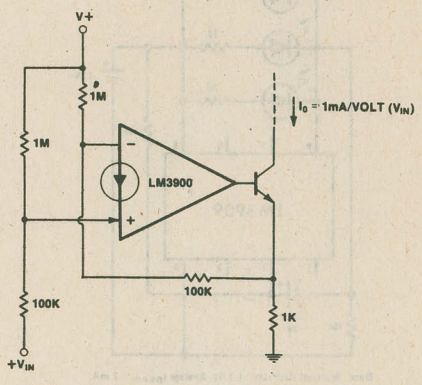
Voltage Regulator



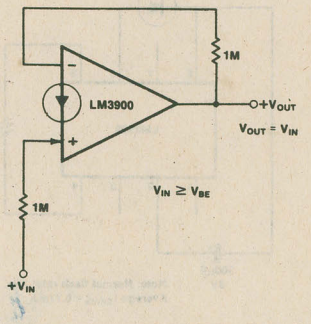
Fixed Current Sources



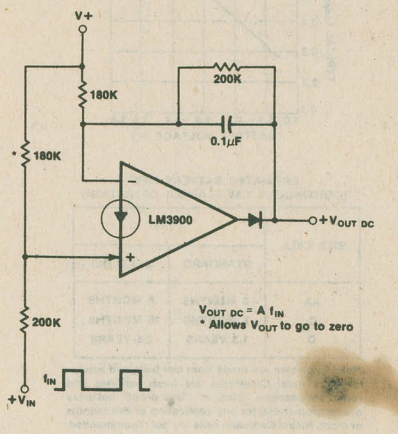
Voltage-Controlled Current Sink (Transconductance Amplifier)



Buffer Amplifier



Tachometer



3909
276-1705

LED FLASHER/OSCILLATOR

GENERAL DESCRIPTION

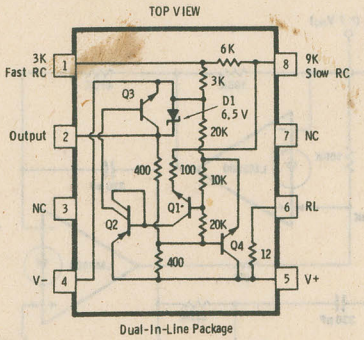
The 3909 is a monolithic oscillator specifically designed to flash Light Emitting Diodes. By using the timing capacitor for voltage boost, it delivers pulses of 2 or more volts to the LED while operating on a supply of 1.5V or less. The circuit is inherently self-starting, and requires addition of only a battery and capacitor to function as a LED flasher.

It has been optimized for low power drain and operation from weak batteries so that continuous operation life exceeds that expected from battery rating.

Application is made simple by inclusion of internal timing resistors and an internal LED current limit resistor.

Timing capacitors will generally be of the electrolytic type, and a small 3V rated part will be suitable for any LED flasher using a supply up to 6V. However, when picking flash rates, it should be remembered that some electrolytics have very broad capacitance tolerances, for example −20% to +100%.

PIN CONNECTION



Dual-In-Line Package

FEATURES

- Operation over one year from one C size flashlight cell
- Bright, high current LED pulse
- Minimum external parts
- Low voltage operation, from just over 1V to 5V
- Low current drain, averages under 0.5 mA during battery life
- Powerful; as an oscillator directly drives an 8Ω speaker

ABSOLUTE MAXIMUM RATINGS

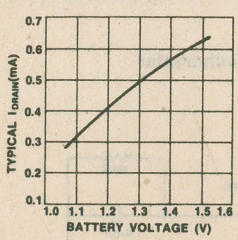
Power Dissipation	500 mW
V+ Voltage	6.4V
Operating Temperature Range	−25°C to +70°C
Pulse Width	6 ms
Peak LED Current	45 mA
Operating Current	75 mA
Flash Frequency	1.3 Hz
High Flash Frequency	1.1 kHz

TYPICAL APPLICATIONS

Warning Flasher High Voltage Powered

TYPICAL OPERATING CONDITIONS

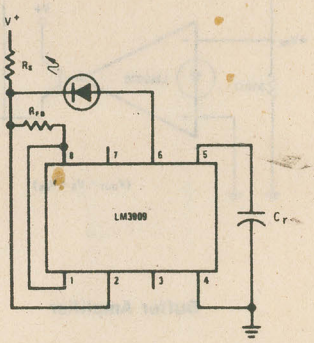
V+	NORMAL FLASH Hz	C_T	R_S 1W	R_{FB}	$V+_{RANGE}$
6V	2	400µF	1K	1.5K	5-25V
15V	2	180µF	3.9K	1K	13-50V
100V	1.7	180µF	43K	1K	85-200V



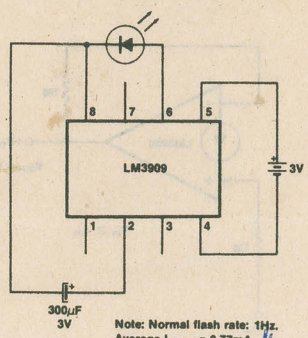
ESTIMATED BATTERY LIFE
(CONTINUOUS 1.5V FLASHER OPERATION)

SIZE CELL	TYPE	
	STANDARD	ALKALINE
AA	3 MONTHS	6 MONTHS
C	7 MONTHS	15 MONTHS
D	1.3 YEARS	2.6 YEARS

Note: Estimates are made from our tests and manufacturers data. Conditions are fresh batteries and room temperature. Clad or "leak-proof" batteries are recommended for any application of five months or more. Nickel Cadmium cells are not recommended.

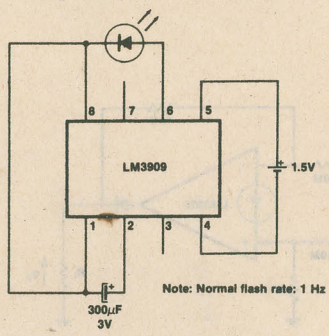


3V Flasher



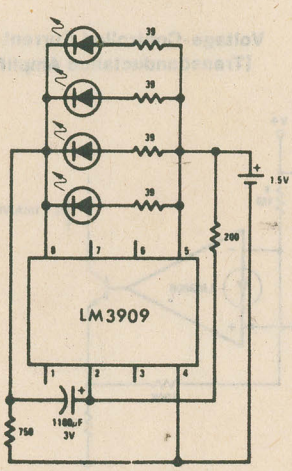
Note: Normal flash rate: 1Hz.
Average I_{DRAIN} = 0.77mA

1.5V Flasher

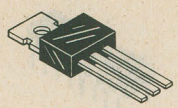


Note: Normal flash rate: 1 Hz

Parallel LED's



Note: Nominal flash rate: 1.3 Hz. Average I_{DRAIN} = 2 mA.



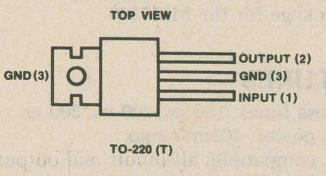
5V VOLTAGE REGULATOR — 7805 (276-1770)
12V VOLTAGE REGULATOR — 7812 (276-1771)
15V VOLTAGE REGULATOR — 7815 (276-1772)

GENERAL DESCRIPTION

This series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

This series will allow over 1.5A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

PIN CONNECTION



FEATURES

- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit

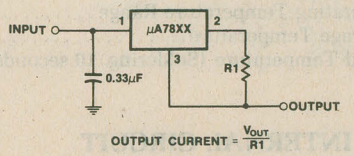
VOLTAGE RANGE

7805 ..... 5V
7812 ..... 12V
7815 ..... 15V

ABSOLUTE MAXIMUM RATINGS

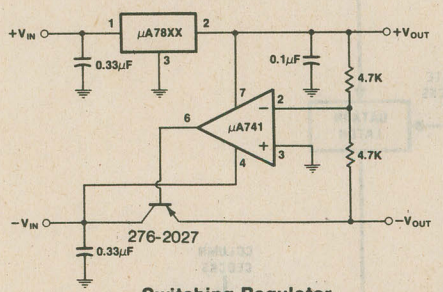
Input Voltage
(Output Voltage Options 5V through 18V) 35V
(Output Voltage Option 24V) 40V
Internal Power Dissipation ..... Internally Limited
Operating Temperature Range ..... 0°C to +70°C
Maximum Junction Temperature ..... 150°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

Current Regulator

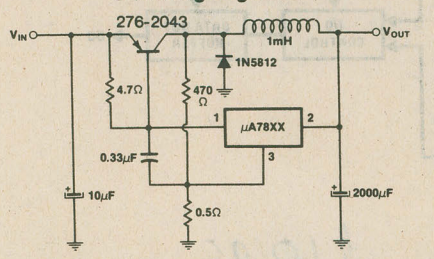


TYPICAL APPLICATIONS

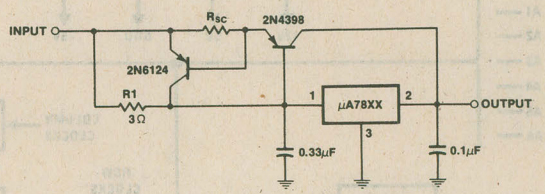
±Tracking Voltage Regulator



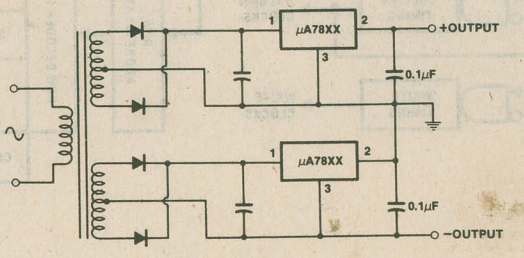
Switching Regulator



High Output Current, Short Circuit Protected



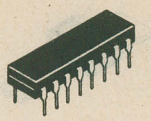
Positive and Negative Regulator



$2.29
P.126

MM5290-055/4116 16K DYNAMIC RAM

276-2505



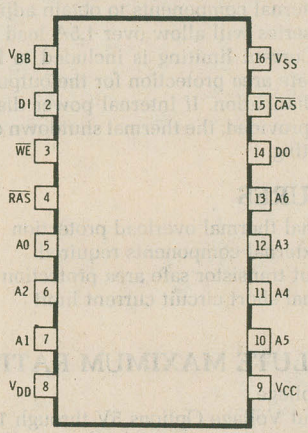
GENERAL DESCRIPTION

The MM5290 is a 16,384 × 1 bit dynamic RAM. It features a multiplexed address input with separate row and column strobes. This added flexibility allows the MM5290 to be used in page mode operation.

The MM5290 must be refreshed every 2 ms. This can be accomplished by performing any cycle which brings the Row Address Strobe active including an RAS-only cycle at each of the 128 row addresses.

N-channel double-poly silicon gate technology is used in the manufacture of the MM5290. This process combines high density and performance with reliability. Greater system densities are achievable by the use of a 16-pin dual-in-line package for the MM5290.

PIN CONNECTION



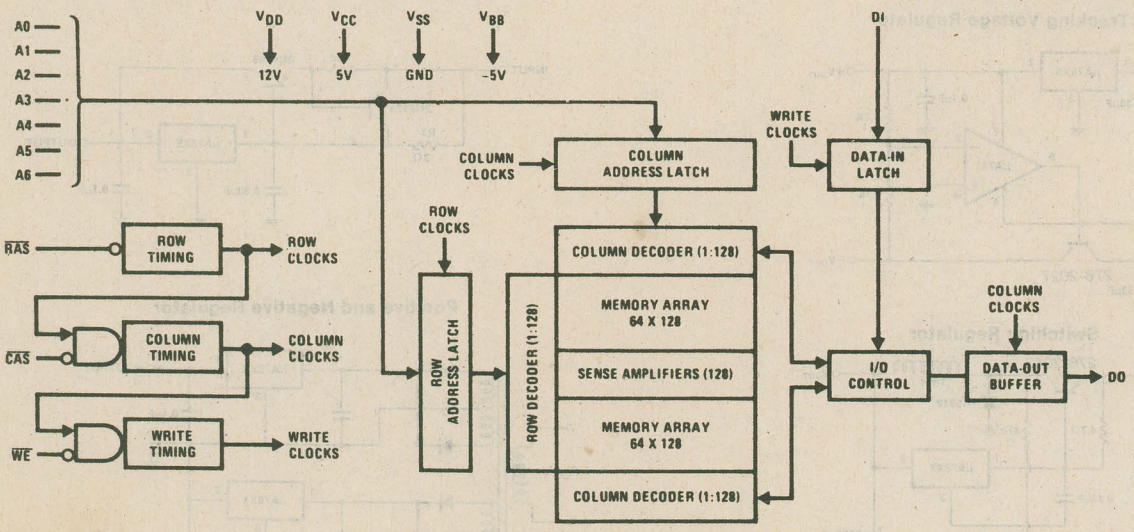
FEATURES

- Access times: 150 ns, 200 ns, 300 ns
- Low power; 462mW max
- TTL compatible: all inputs and output
- Gated CAS—noncritical timing
- Read, wire, read-modify-write and RAS-only refresh cycles
- Page mode operation
- 16-pin DIP.

ABSOLUTE MAXIMUM RATINGS

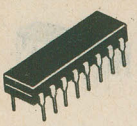
Power Dissipation	1W
Supply Voltage V_{DD}	13.2V
Supply Voltage V_{CC}	5.5V
Voltage on Any Pin Relative to V_{BB} ($V_{SS}-V_{BB}\geq 4.5V$)	−0.3V to +20V
Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

INTERNAL CIRCUIT



$10.95

R186



1024-BIT STATIC RANDOM ACCESS MEMORY

2102L
276-2501

GENERAL DESCRIPTION

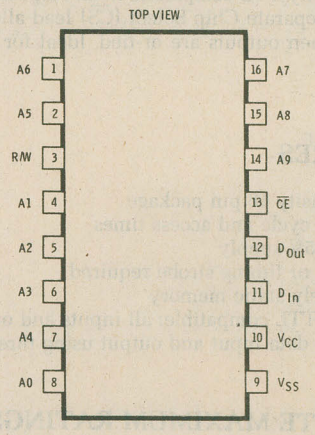
The 2102 L is a 1024-bit random access memory fabricated with high-density, high-reliability, N-channel, silicon-gate technology. For ease of use, the device operates from a single power supply, is directly compatible with TTL and DTL, and requires no clocks or refreshing because of static operation.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avid application of any voltage higher than maximum rated voltages to this high impedance circuit.

FEATURES

- 1024 Word by 1 Bit Organization
- Access Time = 450 nA or less
- Low Power Dissipation—150 mW Typical
- Static Operation
- Single +5-Volt Supply
- Direct TTL/DTL Compatibility
- Three-State Output
- Chip Enable for Memory Expansion
- Cost Effective Data Storage

PIN CONNECTION



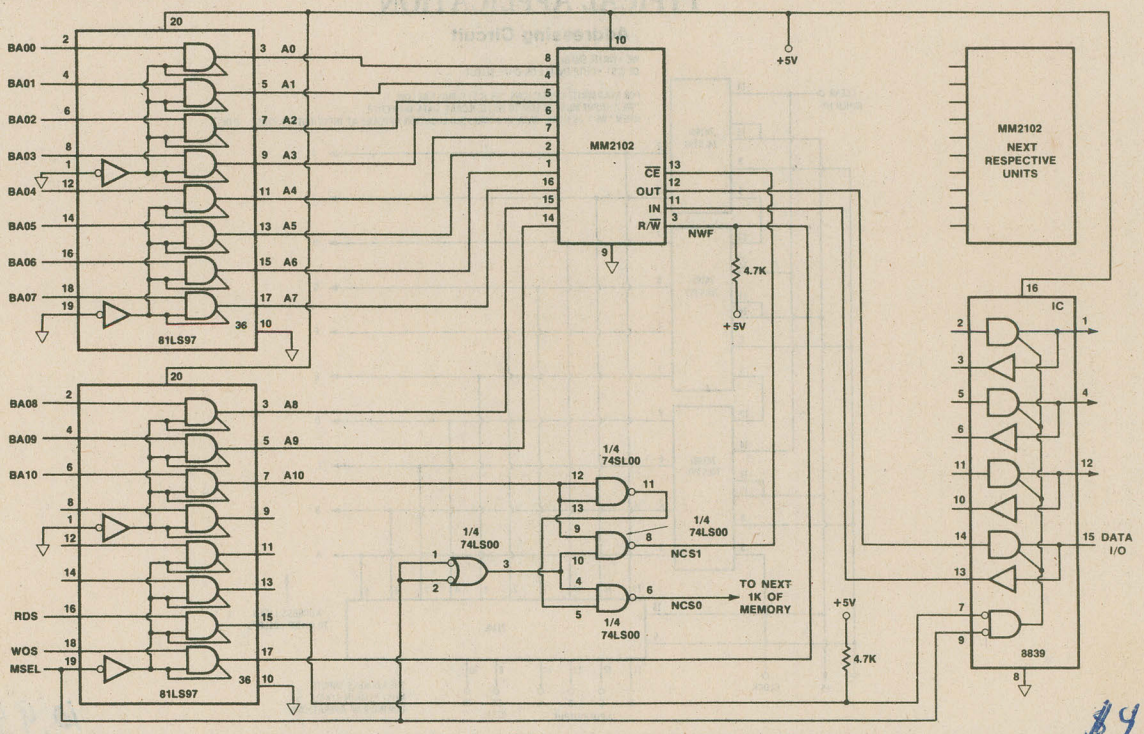
RECOMMENDED DC OPERATING CONDITIONS (Referenced to V_{SS})

Supply Voltage	4.75—5.25 Vdc (MIN-MAX)
Input Low Voltage	−0.3—0.65 Vdc (MIN-MAX)
Input High Voltage	2.2—5.25 Vdc (MIN-MAX)

ABSOLUTE MAXIMUM RATINGS (Referenced to V_{SS})

Supply Voltage	−0.3 to plus 7.0 Vdc
Input Voltage	−0.3 to plus 7.0 Vdc
Operating Temperature Range	0°C to plus 70°C
Storage Temperature Range	−55°C to plus 150°C

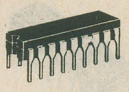
TYPICAL APPLICATION



$4.59
P. 126

2114L/4045 4K STATIC RAM

276-2504

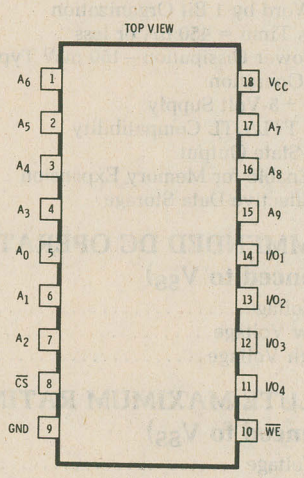


GENERAL DESCRIPTION

The 2114L/4045 is a 4096-bit static Random Access Memory organized as 1024 words by 4-bits using N-channel Silicon-Gate MOS technology. It uses fully DC stable (static) circuitry throughout—in both the array and the decoding—and therefore requires no clocks or refreshing to operate. Data access is particularly simple since address setup times are not required. The data is read out non-destructively and has the same polarity as the input data. Common input/output pins are provided.

It is directly TTL compatible in all respects: inputs, outputs, and a single +5V supply. A separate Chip Select ($\overline{CS}$) lead allows easy selection of an individual package when outputs are or-tied. Ideal for do-it-yourself microcomputers and controllers.

PIN CONNECTION



FEATURES

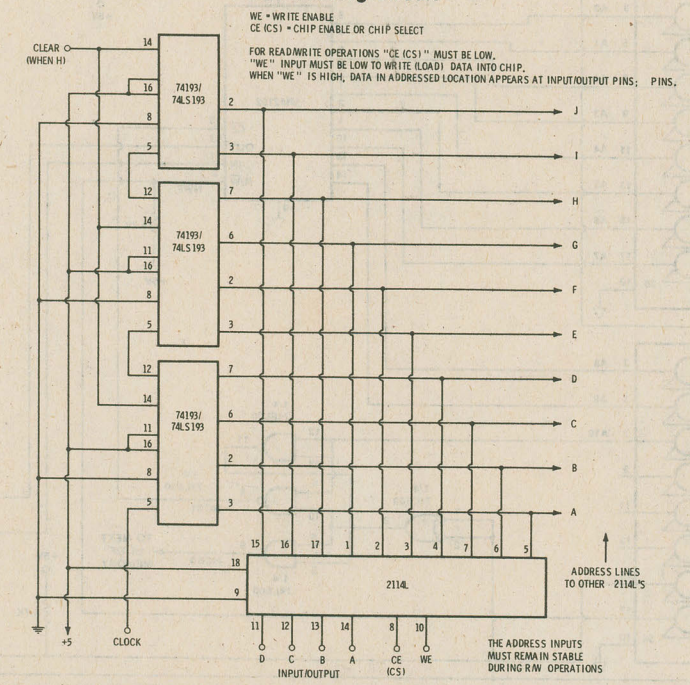
- High density 18 pin package
- Identical cycle and access times
- Single +5V supply
- No clock or timing strobe required
- Completely static memory
- Directly TTL compatible: all inputs and outputs
- Common data input and output using three-state outputs

ABSOLUTE MAXIMUM RATINGS

Temperature Under Bias	−10°C to 80°C
Storage Temperature	−65°C to +150°C
Voltage on Any Pin With Respect to Ground	−0.5V to +7V
Power Dissipation	1.0W
D.C. Output Current	5mA

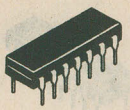
TYPICAL APPLICATION

Addressing Circuit



10.95

P.186



QUADRUPLE TWO-INPUT NAND GATE — 7400 (276-1801) $1.59
QUAD TWO-INPUT NOR GATE — 7402 (276-1811) $1.59
HEX INVERTOR — 7404 (276-1802) $1.59
QUAD TWO-INPUT AND GATE — 7408 (276-1822) $1.59

GENERAL DESCRIPTION

Employing TTL (Transistor-Transistor-Logic) to achieve high speed at moderate power dissipation, these gates provide the basic functions used in the implementation of digital integrated circuit systems. Characteristics of the circuits include high noise immunity, low output impedance, good capacitive drive capability, and minimal variation in switching times with temperature.

The 7402 is a quad 2-input NOR gate utilizing TTL (Transistor-Transistor Logic) to achieve high speed at nominal power dissipation.

The 7404 is a hex inverter utilizing TTL to achieve high speed at nominal power dissipation. It is totally compatible with other Series 74 devices.

7408 provides the non-inverting AND function in the popular quad 2-input pin configuration.

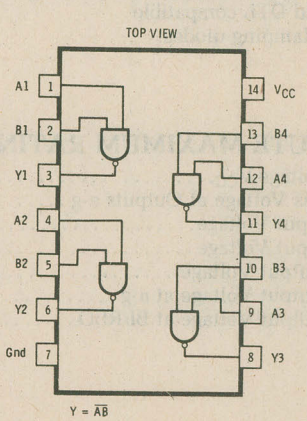
FEATURES

- Guaranteed Noise Immunity 400 mV
- Average Propagation Delay 13 ns
- Average Propagation Delay 12 ns (with 50 pF) (7402, 7404)
- Average Power Dissipation 10 mW per gate
- Average Power Dissipation 14 mW per gate (7402)
- Typical Noise Immunity 1V
- Fan Out 10

ABSOLUTE MAXIMUM RATINGS

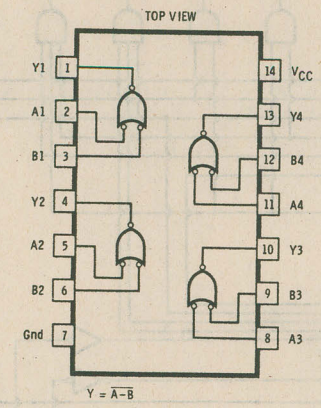
V_{CC}	5.25V
Input Voltage	5.5V
Storage Temperature Range	−65°C to +150°C
Fan-Out	10
Lead Temperature (Soldering, 10 sec)	300°C
Supply Voltage (V_{CC})	4.75—5.25V
Temperature (T_A)	0°C to 70°C

PIN CONNECTION



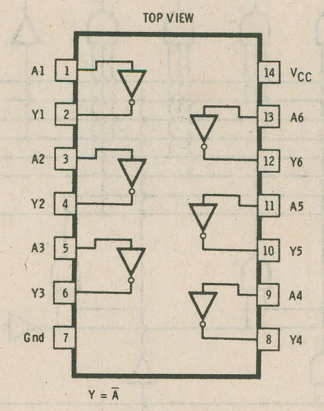
7400

PIN CONNECTION



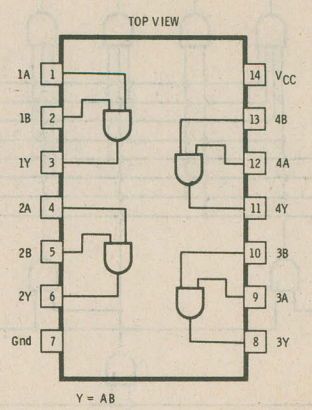
7402

PIN CONNECTION



7404

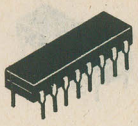
PIN CONNECTION



7408

7447
276-1805
7448
276-1816

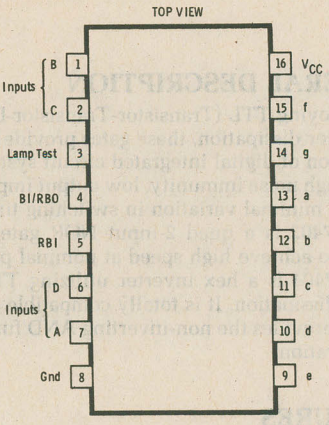
BCD TO SEVEN-SEGMENT DECODER/DRIVER



GENERAL DESCRIPTION

This versatile binary-coded-decimal series of 7-segment display drivers fulfills a wide variety of requirements for most active high (common cathode) and active low (common anode) Light Emitting Diodes (LED) or lamp displays. Each device fully decodes a 4-bit BCD input into a number from 0 through 9 in the standard 7-segment display format, and BCD numbers above 9 into unique patterns that verify operation. All circuits operate off of a single 5.0V supply. The 7447 outputs withstand 15V at a maximum leakage current of 250 μA.

PIN CONNECTION



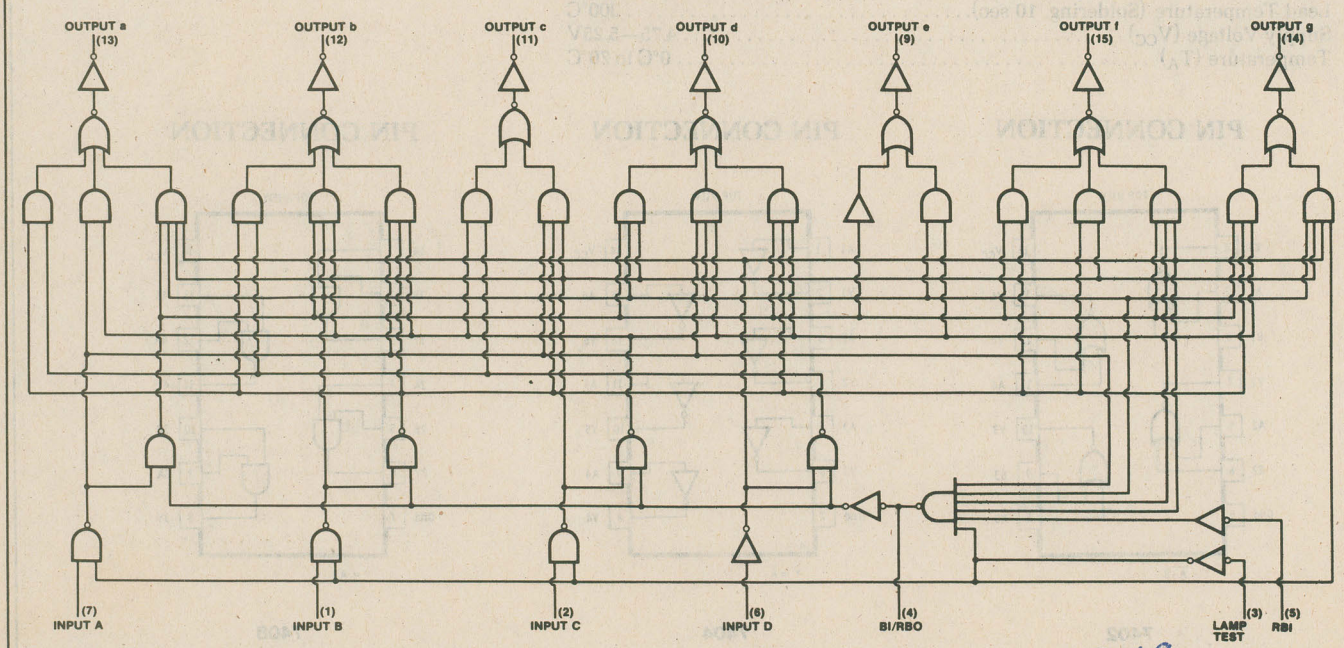
FEATURES

- Lamp-test input
- Leading railing zero suppression (RBI and RBO)
- Blanking input that may be used to modulate lamp intensity or inhibit output
- TTL and DTL compatible
- Input clamping diodes

ABSOLUTE MAXIMUM RATINGS

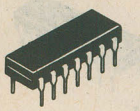
Supply Voltage V_{CC}	4.75-5.25V
Continuous Voltage at Outputs a-g	Max. 5.5V
Logic 1 Input Voltage	Min. 2V
Logic 0 Input Voltage	Max. 0.8V
Logic 0 Output Voltage	Max. 0.4V
Logic 1 Output Voltage at a-g	Min. 2.4V
Logic 1 Output Voltage at BI/RBO	Min. 2.4V

INTERNAL CIRCUIT



299

D126



DUAL JK MASTER/SLAVE FLIP FLOP

7473
276-1803

GENERAL DESCRIPTION

The flip flops described herein are TTL (Transistor-Transistor Logic) dual JK Master/Slave flip flops. Asynchronous CLEAR inputs are provided on the flip flops. The device is totally monolithic and designed for use in high speed control and counting applications, where economy is required, and multiple data inputs are not required. These devices meet all of the electrical and mechanical requirements of the equivalent 74 device.

FEATURES

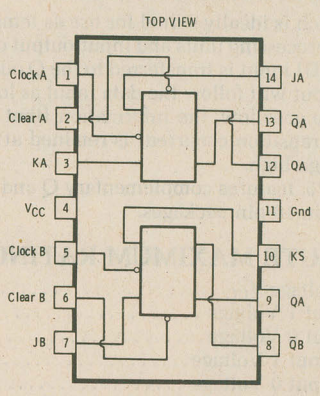
- High speed of operation 25 MHz toggling
- Optimum power dissipation 45 mW/ff
- High noise immunity 1V
- Guaranteed Clock Skew 15 ns

This device also features a special clock line clamp to reduce ringing and prevent false clocking. In addition, the usual speed-power efficiency and high output drive-capability normally gained with TTL circuits are retained.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage 5.25V
Input Voltage 5.5V
Fan Out 10
Storage Temperature Range ..... −65°C to +150°C
Operating Temperature Range ..... 0°C to +70°C
Lead Temperature (Soldering 10 Sec) ..... 300°C

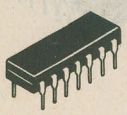
PIN CONNECTION



TRUTH TABLE (Each Flip-Flop)

t_n		t_{n+1}
INPUT J	INPUT K	OUTPUT Q
L	L	Q_n
L	H	L
H	L	H
H	H	$\bar{Q}_n$

t_n = bit time before clock pulse.
t_{n+1} = bit time after clock pulse.
L = Low Level
H = High Level



DUAL D FLIP FLOP

7474
276-1818

GENERAL DESCRIPTION

The 7474 is designed for use where the flexibility of 2 inputs is not required. It has only a single DATA (D) input. The logical level applied to this input is transferred to the Q output when the clock pulse voltage rises to a logical 1. Since only one pin is used for data entry, fully asynchronous (both PRESET and CLEAR) capability can be provided in a 14 pin dual-in-line package.

ABSOLUTE MAXIMUM RATINGS

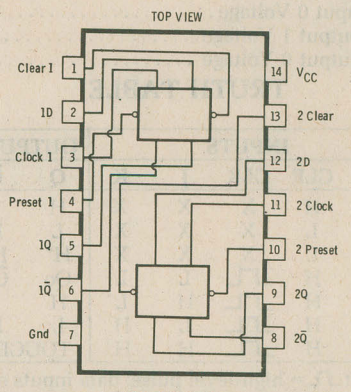
Supply voltage V_{CC} ..... 4.75—5.25V (MIN-NOM)
Normalized fan-out from each output, N ..... 10 (MAX)
Width of clock pulse, t_p (clock) ..... 30 ns (MIN)
Width of preset pulse, t_p (preset) ..... 30 ns (MIN)
Width of clear pulse, t_p (Clear) ..... 30 ns (MIN)
Operating free-air temperature range, T_A ..... 0—70°C (MIN-MAX)

TRUTH TABLE (Each Flip-Flop)

t_n	t_{n+1}	
INPUT D	OUTPUT Q	OUTPUT $\bar{Q}$
L	L	H
H	H	L

t_n = bit time before clock pulse.
t_{n+1} = bit time after clock pulse.
L = Low Level
H = High Level

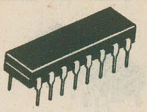
PIN CONNECTION



POSITIVE LOGIC:
Low Input to preset sets Q to logical 1
Low Input to clear sets Q to logical 0
Preset and clear are independent of clock

$1.49
$126

7475 QUAD LATCH
276-1806



GENERAL DESCRIPTION

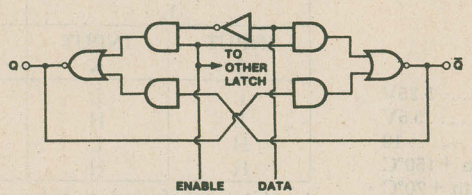
This latch is ideally suited for use as temporary storage for binary information between processing units and input/output or indicator units. Information present at a data (D) input is transferred to the Q output when the enable (G) is high, and the Q output will follow the data input as long as the enable remains high. When the enable goes low, the information (that was present at the data input at the time the transition occurred) is retained at the Q output until the enable is permitted to go high.

The 7475, features complementary Q and Q outputs from a 4-bit latch, and are available in 16-pin packages.

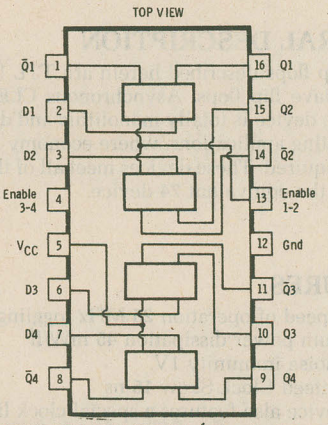
ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC} ..... 4.75—5.25V
Logic Input 1 Voltage ..... 2.0V Min.
Logic Input 0 Voltage ..... 0.8V Max.
Logic Output 1 Voltage ..... 2.4V Min.
Logic Output 0 Voltage ..... 0.4V Max.

INTERNAL CIRCUIT (Each Latch)



PIN CONNECTION



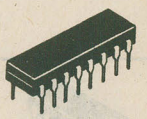
TRUTH TABLE (Each Latch)

INPUTS		OUTPUTS	
D	G	Q	$\overline{Q}$
L	H	L	Q
H	H	H	$\overline{L}$
X	L	Q_0	$\overline{Q}_0$

X = Don't Care L = Low Level H = High Level
Q_0 = The Level of Q Before the High-to-Low Transition of G

$1.99

7476 DUAL JK MASTER/SLAVE FLIP-FLOP
276-1813



GENERAL DESCRIPTION

Incorporates separate presets, clears, and clocks. Clock pulse controls inputs to master section, and also regulates coupling between master and slave sections.

ABSOLUTE MAXIMUM RATINGS

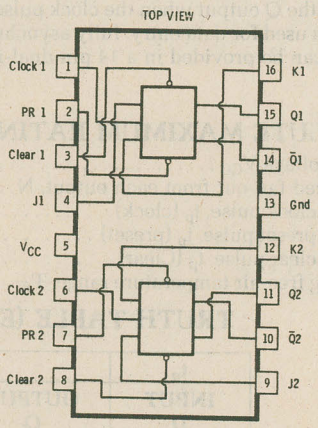
Supply Voltage V_{CC} ..... 4.75—5.25V
Logic Input 1 Voltage ..... 2.0V Min.
Logic Input 0 Voltage ..... 0.8V Max.
Logic Output 1 Voltage ..... 2.4V Min.
Logic Output 0 Voltage ..... 0.4V Max.

TRUTH TABLE

INPUTS					OUTPUTS	
PR	CLR	CLK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	⊓	L	L	Q_0	$\overline{Q}_0$
H	H	⊓	H	L	H	L
H	H	⊓	L	H	L	H
H	H	⊓	H	H	TOGGLE	

Notes: ⊓ = high-level pulse; data inputs should be held constant while clock is high; data is transferred to output on the falling edge of the pulse.
Q_0 = the level of Q before the indicated input conditions were established
TOGGLE: Each output changes to the complement of its previous level on each active transition (pulse) of the clock.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.
X = Don't Care L = Low Level H = High Level

PIN CONNECTION



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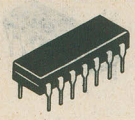


DIVIDE BY 2 or 5, BCD COUNTER

7490
276-1808

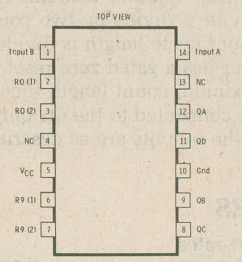
GENERAL DESCRIPTION

This monolithic binary-coded-decimal contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five.

This counter has a gated zero reset and gated set-to-nine inputs for use in BCD nine's complement applications.

To use maximum count length (decade, divide-by-twelve, or four-bit binary, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the appropriate truth table. A symmetrical divide-by-ten count can be obtained from the 90 counter by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A.

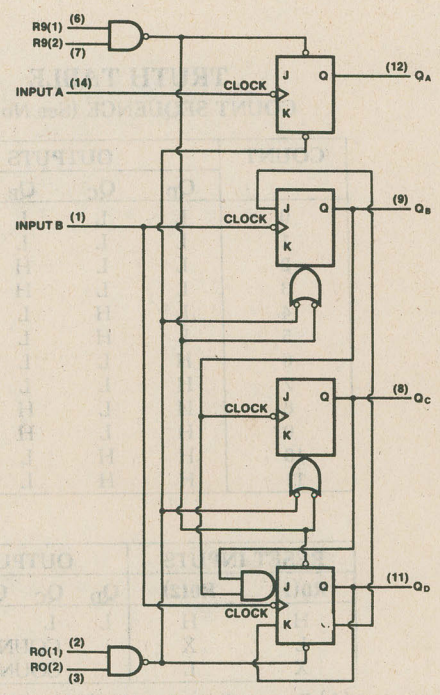
PIN CONNECTION



TYPICAL RATINGS

Typical Power Dissipation	145 mW
Count Frequency	42 MHz
High Level Input Voltage	(Min) 2V
Low Level Input Voltage	(Max) 0.8V
High Level Input Current	800 μA
Low Level Output Current	(Max) 16 mA

INTERNAL CIRCUIT



The J and K inputs shown without connection are for reference only and are functionally at a high level.

Notes:

(A) Output Q_A is connected to input B for BCD count.

(B) Output Q_D is connected to input A for bi-quinary count.

TRUTH TABLES

RESET/COUNT TRUTH TABLE

RESET INPUTS				OUTPUTS			
RO(1)	RO(2)	R9(1)	R9(2)	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

BCD COUNT SEQUENCE
(See Note A)

COUNT	OUTPUTS			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

BI-QUINARY (5-2)
(See Note B)

COUNT	OUTPUTS			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

Output Q_A is connected to input B for BCD count.
Output Q_D is connected to input A for bi-quinary count.
L = Low Level
H = High Level

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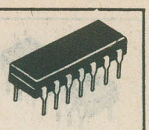
7492
276-1819

DECADE, DIVIDE BY 12, AND BINARY COUNTER



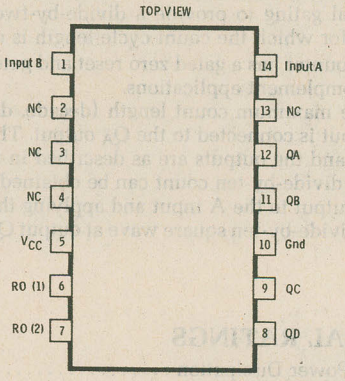
GENERAL DESCRIPTION

This monolithic counter contains four master-slave flip flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divided by six.

This counter has a gated zero reset.

To use maximum count length (decade, divide-by-twelve, or four-bit binary), the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the appropriate truth table.

PIN CONNECTION



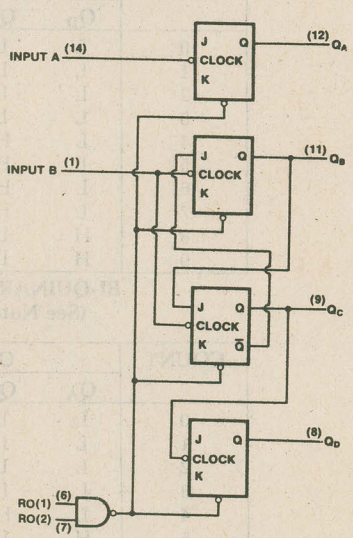
FEATURES

- High count rates
- Choice of counting modes . . . BCD, Bi-quinary, divide-by-twelve, binary
- Input clamp diodes limit high speed termination effects
- Fully TTL and CMOS compatible

TYPICAL RATINGS

Supply Voltage..... 5.25V
Typical Power Dissipation..... 130 mW
Count Frequency..... 42 MHz
Operating Temperatures..... 0° to 70°C
Storage Temperature..... −65°C to 150°C

INTERNAL CIRCUIT



The J and K inputs shown without connection are for reference only and are functionally at a high level.

TRUTH TABLE

COUNT SEQUENCE (See Note A)

COUNT	OUTPUTS			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	H	L	L	L
7	H	L	L	H
8	H	L	H	L
9	H	L	H	H
10	H	H	L	L
11	H	H	L	H

RESET INPUTS		OUTPUTS			
R0(1)	R0(2)	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

(A) Output Q_A is connected to input B.
X = Don't Care
L = Low Level
H = High Level

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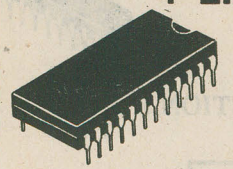
4-LINE TO 16-LINE DECODER/DEMULTIPLEXER

74154
276-1834



GENERAL DESCRIPTION

The 74154 is a TTL monolithic 4-line-to-16-line decoder which allows decoding of a 4 bit binary coded input into one of 16 separate outputs. The device is provided with two strobe lines, both of which have to be in the low state in order to perform the decoding function; if either of the strobes is high, all 16 outputs will remain high. The device can be used as a demultiplexer by passing information from one of the strobes (the other being low) to an output selected by the 4 line input address.

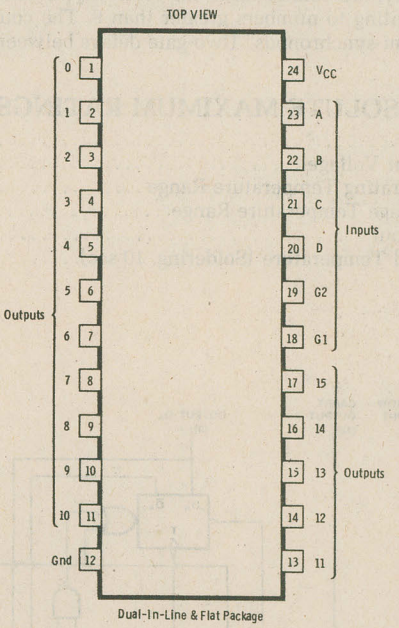
FEATURES

- All inputs contain clamp diodes
- Unit performs as a one line to 16 line demultiplexer
- Unit performs as a decoder of a 4 bit binary input to 1 or 16 outputs
- Typical propagation delay is 20 ns from inputs and 17 ns from strobe

ABSOLUTE MAXIMUM RATINGS

V_{CC} 5.25V
Input Voltage 5.5V
Operating Temperature Range ..... 0°C to 75°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PIN CONNECTION

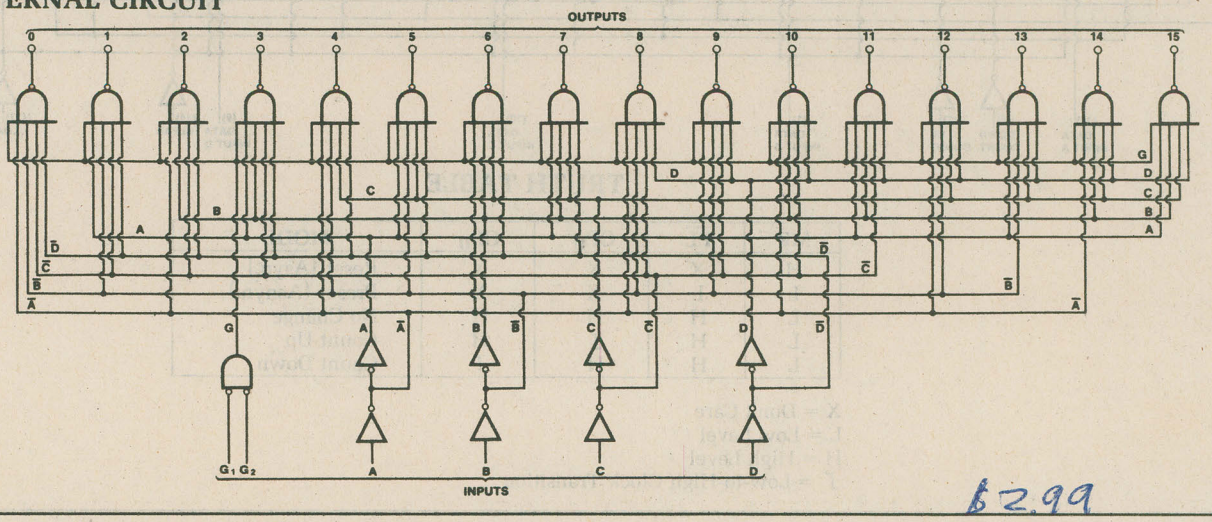


TRUTH TABLE

INPUTS					OUTPUTS														
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = High Level
L = Low Level
X = Don't Care

INTERNAL CIRCUIT



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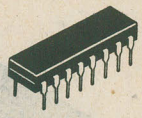
74192
276-1831

UP/DOWN DECADE COUNTER

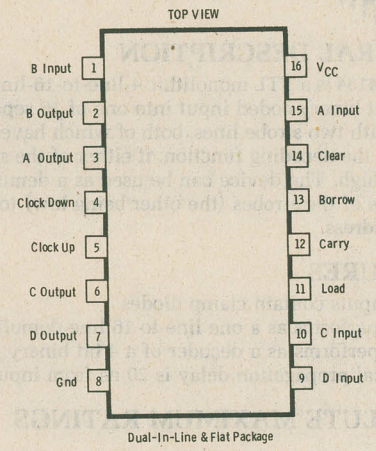


GENERAL DESCRIPTION

The 74192 is a TTL, up-down decade counter which is capable of being preset to any number from 0 through 9. A load input controls the asynchronous entry of these numbers, and sets all outputs to appropriate state.

Counting is performed through two clock lines—one controlling the count in the up direction, and the other in the down direction. Two outputs, Borrow and Carry, are connected to the clock inputs of subsequent counters to provide for counting to numbers greater than 9. The counter is synchronous by itself, and "semi-synchronous" (two-gate delays between stages) when cascaded.

PIN CONNECTION

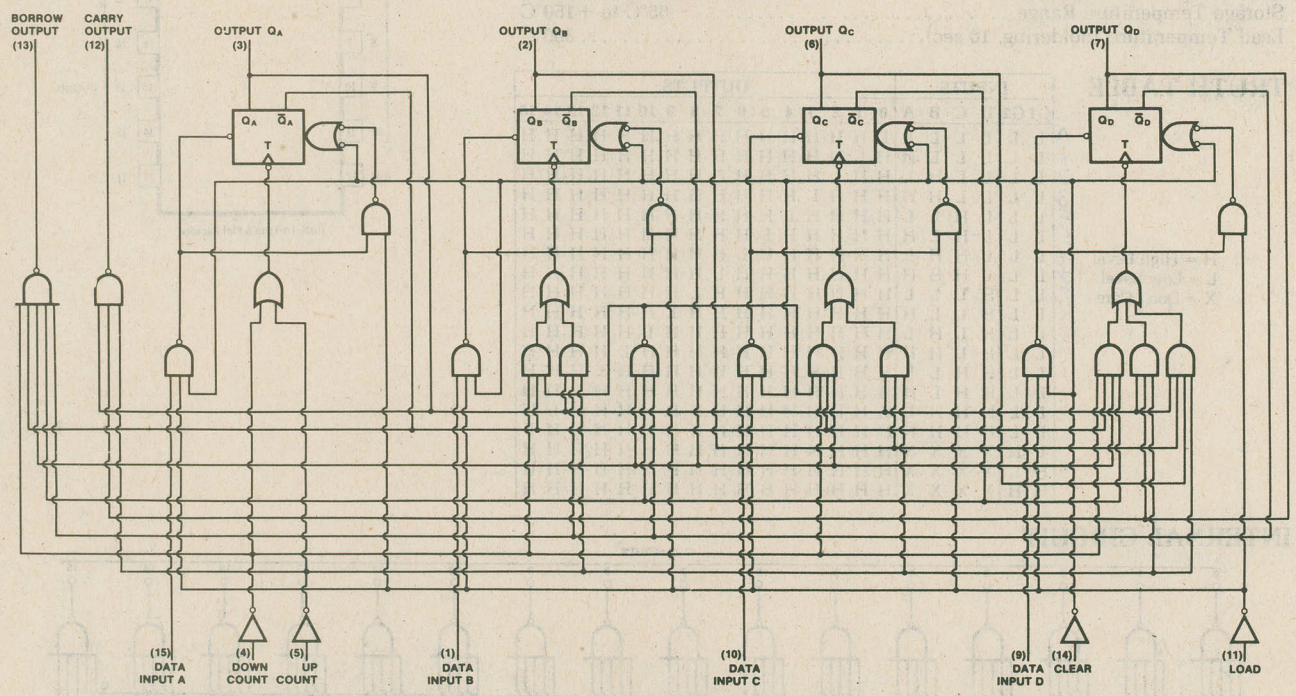


Dual-In-Line & Flat Package

ABSOLUTE MAXIMUM RATINGS

V_{CC} 5.25V
Input Voltage 5.5V
Operating Temperature Range ..... 0°C to +70°C
Storage Temperature Range ..... −65°C to +150°C
Fanout 10
Lead Temperature (Soldering, 10 sec) ..... 300°C

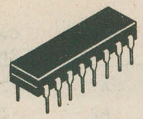
INTERNAL CIRCUIT



TRUTH TABLE

MR	$\overline{PL}$	CP_U	CP_D	MODE
H	X	X	X	Reset (Asyn.)
L	L	X	X	Preset (Asnyn.)
L	H	H	H	No Change
L	H	⌐	H	Count Up
L	H	H	⌐	Count Down

X = Don't Care
L = Low Level
H = High Level
⌐ = Low-to-High Clock Transition



SYNCHRONOUS UP/DOWN COUNTER WITH DUAL CLOCK

74193
276-1820

GENERAL DESCRIPTION

The 74193 is a 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously, so that the outputs change together when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple-clock) counters.

The outputs of the four master-slave flip-flops are triggered by a low-to-high level transition of either count (clock) input. The direction of counting is determined by which count input is pulsed, while the other count input is held high.

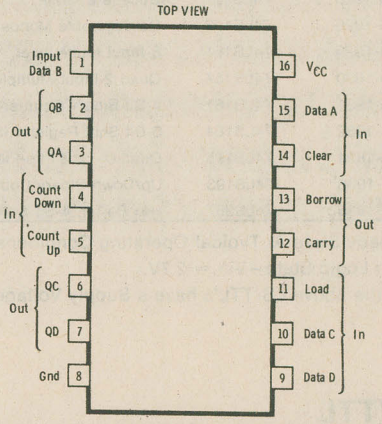
All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the inputs while the load input is low. The output will change independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

A clear input has been provided which, when taken to a high level, forces all outputs to the low level; independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements of clock drivers, etc., required for long words.

FEATURES

- Fully independent clear input
- Cascading circuitry provided internally
- Synchronous operation
- Individual preset each flip-flop

PIN CONNECTION

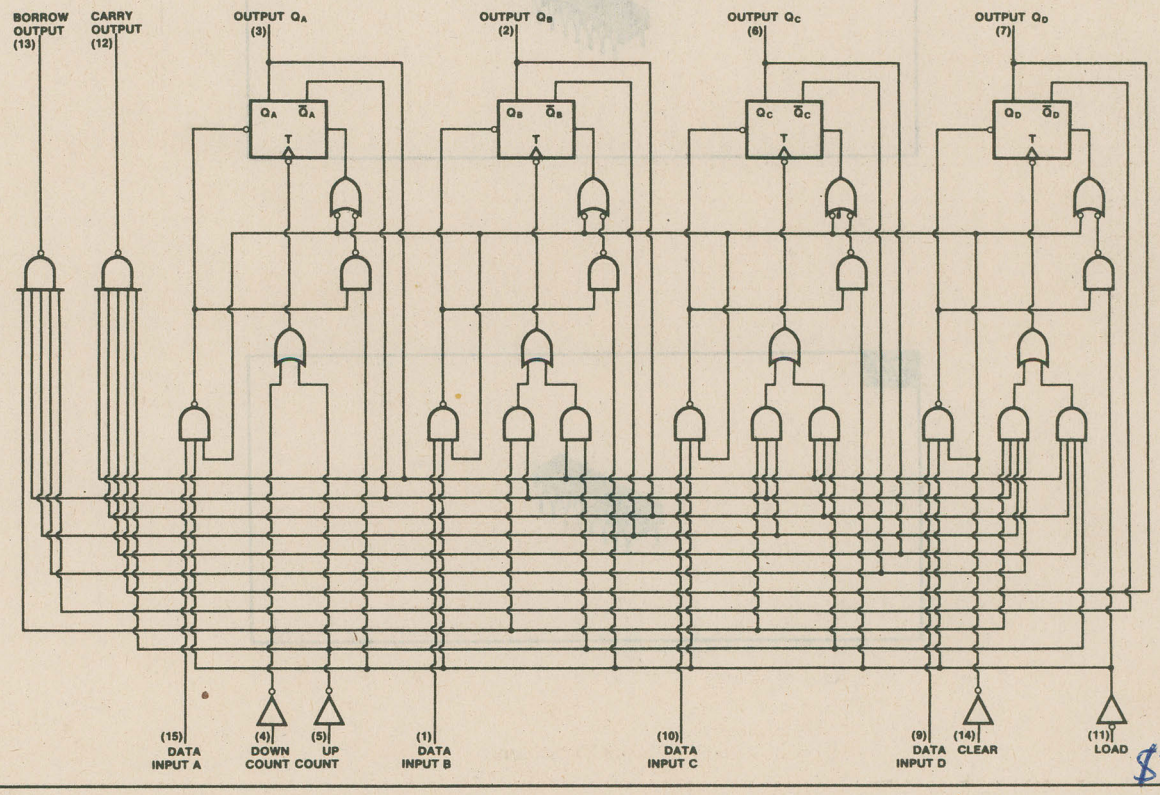


Low input to load sets QA=A, QB=B, QC=C, QD=D.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC} ..... 4.75—5.25V (MIN-MAX)
Normalized Fan-out from Each Output, N ..... 10 (MAX)
Input Count Frequency, f Count ..... 0—25 MHz (MIN-MAX)
Width of any Input Pulse, tw ..... 20 ns (MIN)
Data Setup Time, t_{setup} ..... 20 ns (MIN)
Data Hold Time, t_{hold} ..... 1 ns (MIN)
Operating Free-air Temperature Range, Ta ..... 0—70°C (MIN-MAX)

INTERNAL CIRCUIT



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LS/TTL

Catalog Number	Direct Commercial Equivalent	Description	Maximum Ratings: Turn On Delay (ns)	Turn Off Delay (ns)	Fan Out Per Internal Circuit	Power Diss. (mW)	Logic Diag.	Case Style
276-1900	74LS00	Quad 2-Input NAND Gate	10	10	5	22	A1	Z1
276-1902	74LS02	Quad 2-Input NOR Gate	10	10	5	27	A2	Z1
276-1904	74LS04	Hex Inverter	10	10	0.5*	33	A3	Z1
276-1908	74LS08	Quad 2-Input And Gate	13	11	5	44	A4	Z1
276-1915	74LS32	Quad 2-Input OR Grate	11	11	5	49	A5	Z1
276-1918	74LS73	Dual JK Flip-Flop	20	20	2*	40	A7	Z1
276-1819	74LS74	Dual D Flip-Flop	30	20	1*	40	A8	Z1
276-1920	74LS75	4-Bit Bi-Stable Latch	25	27	2*	60	A6	Z2
276-1923	74LS90	Decade Counter	50	48	0.5*	75	A11	Z1
276-1926	74LS123	Retriggerable Monostable Multivibrator	80	80	10	100	A12	Z2
276-1929	74LS151	8-Input Multiplexer	27	33	0.5*	50	A9	Z2
276-1930	74LS157	Quad 2-Input Multiplexer (Non Investing)	27	23	1*	80	A13	Z2
276-1931	74LS161	4-Bit Binary Counter-A Synchronous Reset	27	25	1*	160	A10	Z1
276-1932	74LS164	8-Bit Shift Register (Serial In Parallel Out)	32	27	0.5*	135	A14	Z1
276-1834	74LS175	Quad D-Type Flip-Flop With Clear	28	24	0.5*	75+	A15	Z2
276-1936	74LS193	Up/Down Binary Counter	28	31	0.5*	170	A17	Z2
276-1835	74LS367	Hex Buffer, 4-Bit & 2-Bit (3 State)	16	10	0.5*	120	A16	Z2

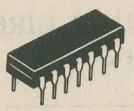
+ Steady State At Typical Operating Conditions.

* High Logic State—Vin = 2.7V.

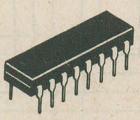
All of the above LS/TTL's have a Supply Voltage Range of 4.75V—5.25V, a Temperature Range of 0-70°C and a Noise Immunity Range of 300-700.

LS/TTL CASE STYLES

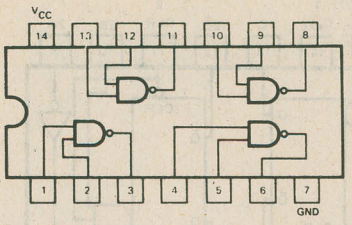
Z1



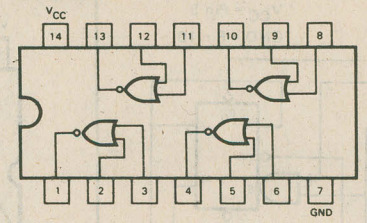
Z2



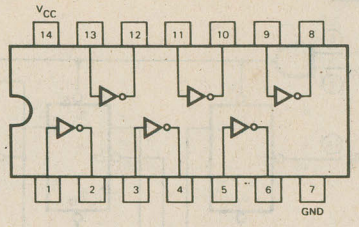
A1



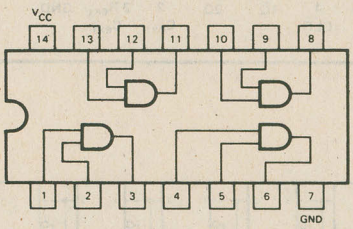
A2



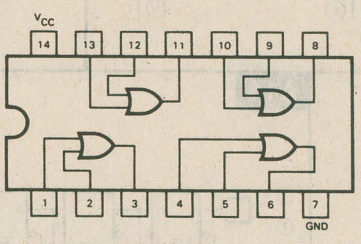
A3



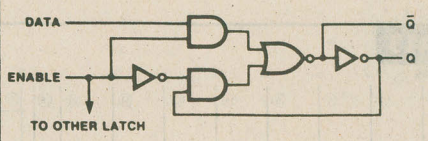
A4



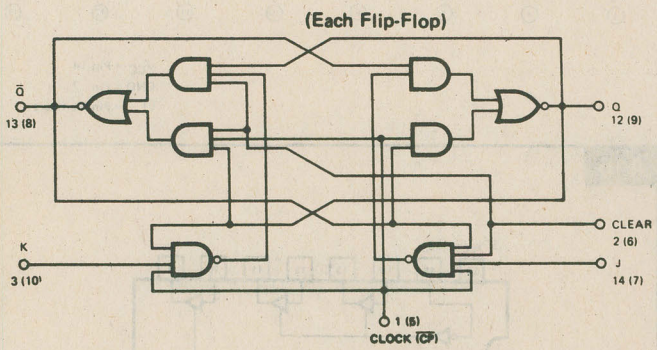
A5



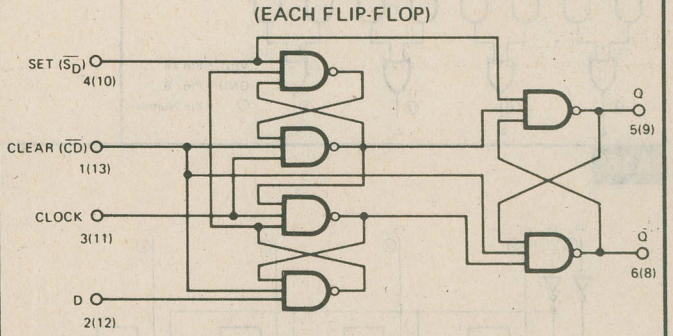
A6



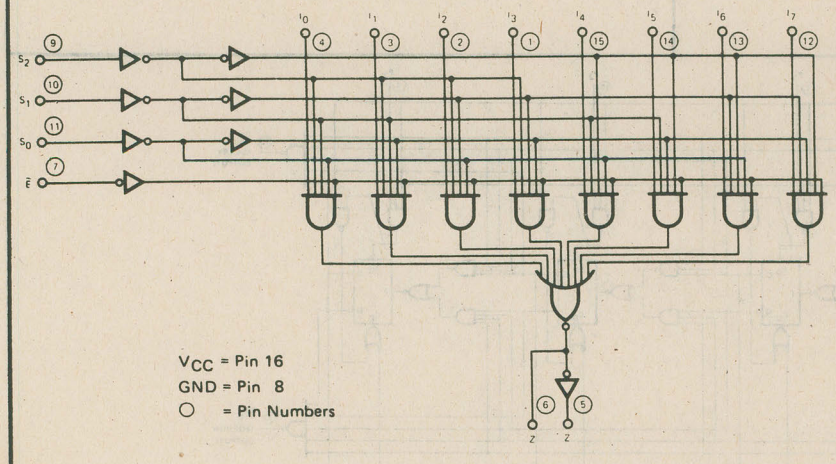
A7



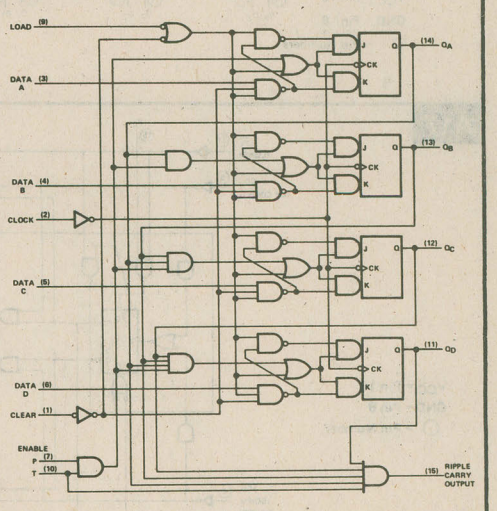
A8



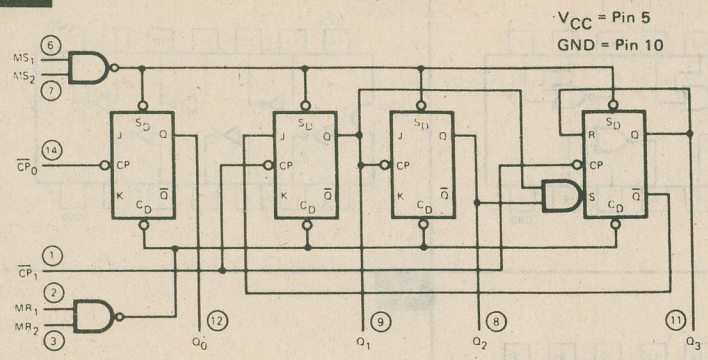
A9



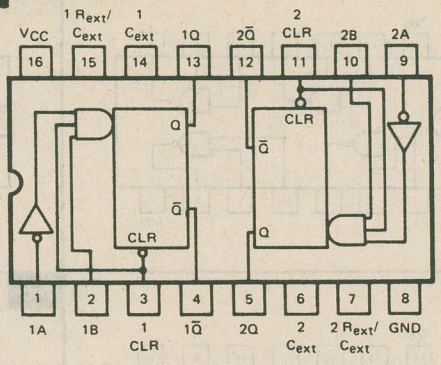
A10



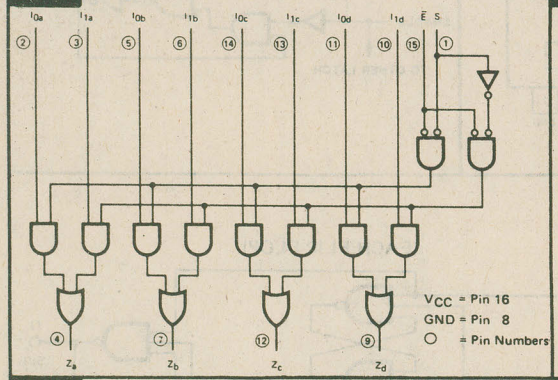
A11



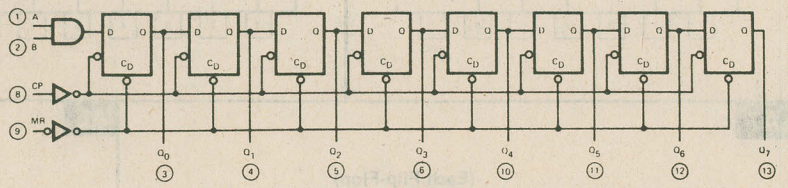
A12



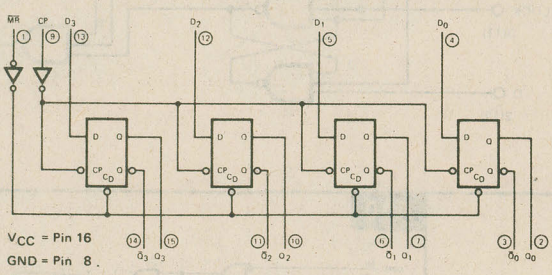
A13



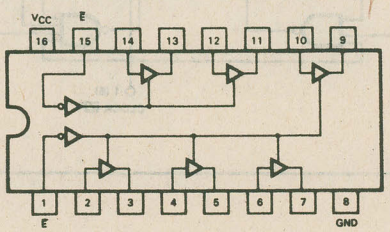
A14



A15



A16



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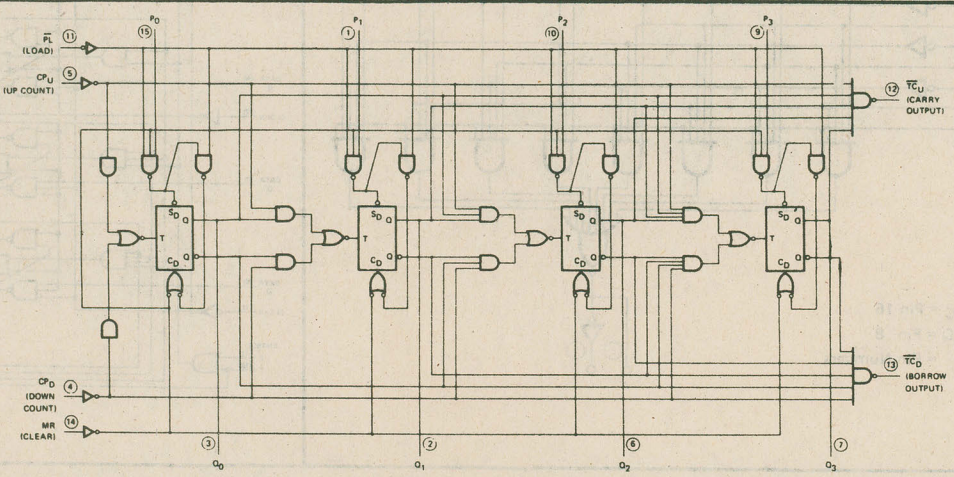


IMPORTANT SUGGESTIONS ON THE USE AND REPLACEMENT OF TRANSISTORS

You can use various styles and sizes of transistors in any given circuit application, as long as the electrical characteristics of the device are within the required range of operation. Thus, a tab-type device can be used to replace a TO-3 or TO-66 case device; or a small epoxy-type device can be used in place of TO-5 or other size transistor.

Generally speaking, you must observe the following maximum characteristics of a transistor when contemplating substitution or selection:

Power dissipation
Maximum collector current
Maximum collector-to-emitter voltage
Maximum collector-to-base voltage
Maximum emitter-to-base voltage

Also, it is useful to consider the following characteristics for actual circuit operation:

Gain
Frequency limitations

Caution: It may be necessary in some cases to adjust bias values to achieve required operation. With tuned circuits, it is a good practice to check alignment after replacing any transistor.

When replacing power transistors, always check driver devices to be sure they are OK. Also, check other circuit components to be sure they were not shorted (or otherwise defective) when the original device failed. If you fail to correct such problems before applying power to the circuit once again, the replacement transistor could easily be permanently damaged. Be sure to use proper heat-sink precautions and use silicon grease to reduce the thermal resistance between the case of the transistor and the heat-sink.

Always observe temperature limitations as specified with transistor ratings.

It almost goes without saying, but let us remind you anyway—

Always observe voltage polarity with all semiconductor devices.

CROSS-REFERENCE/SUBSTITUTION LISTING

Most users of semiconductors realize that it is almost impossible to guarantee absolute equivalents (as in the case of tubes). Thus, the only way to create replacement or cross-reference listings is by carefully evaluating each characteristic of both devices (original transistor and the possible alternate). This is how the Technical Staff of Radio Shack went about preparing the following cross-reference/replacement lists.

IMPORTANT NOTE

We caution you that in any cases the listed cross reference ARCHER device may be different in appearance, size or mounting style. Thus, before beginning replacement or installation procedues, check to be sure you have enough room for proper mounting.

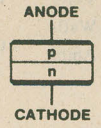
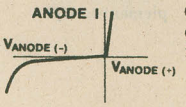
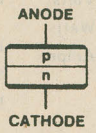
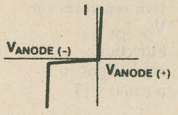
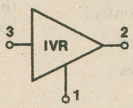
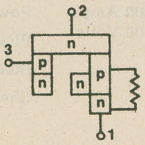
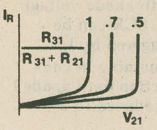
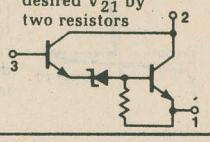
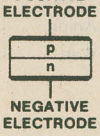
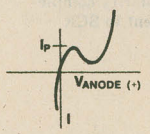
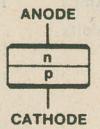
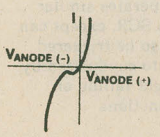
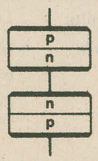
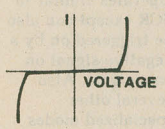
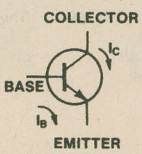
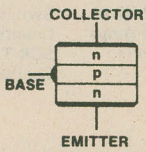
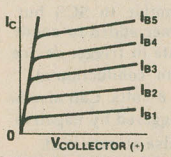
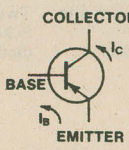
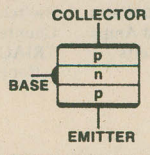
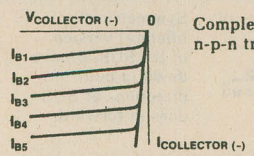
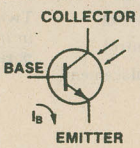
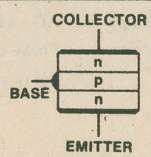
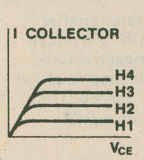
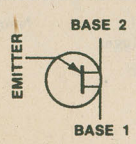
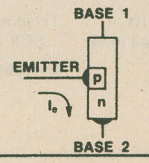
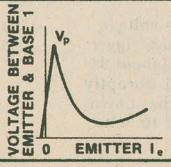
Also, when making substitutions or replacements in radio or high frequency circuitry, it may be necessary to realign tunable circuit elements. This is true even when making **exact** replacements (junction capacitances normally vary between devices even from the same production run).

Information contained in this guide is based on the latest available data and is believed to be accurate. Every care has been taken to assure technical accuracy. However, Radio Shack does not assume responsibility for any contingencies of the use of this information. Nor does Radio Shack assume any responsibility for any infringements of patents or other rights of third parties which may result from its use.

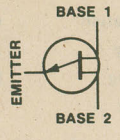
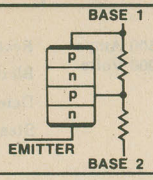
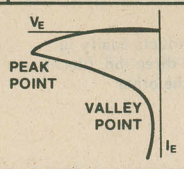
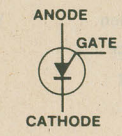
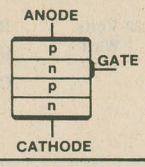
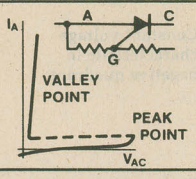
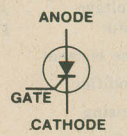
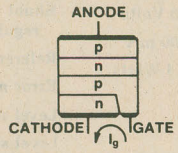
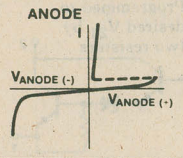
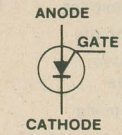
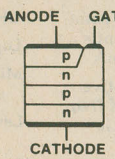
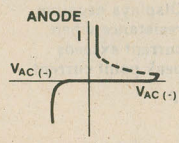
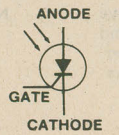
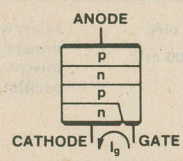
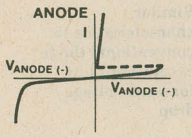
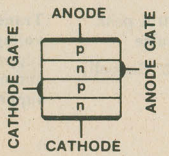
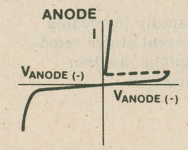
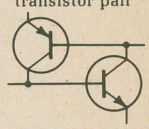
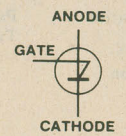
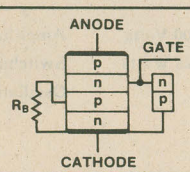
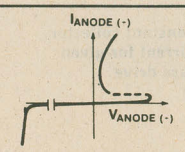
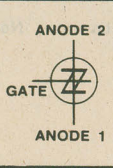
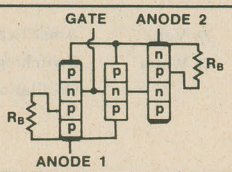
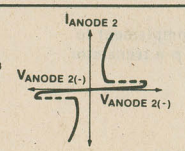
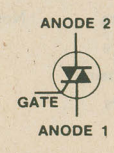
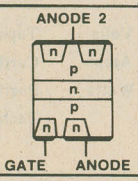
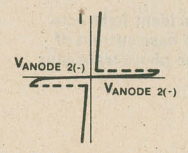
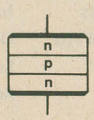
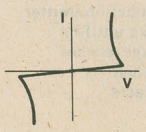
When you are looking for a specific number and it does not show up in the following listing—refer to the technical data provided for our line of ARCHER devices. With this information you probably will be able to make a suitable substitution.

NOTES

MAJOR SEMICONDUCTOR COMPONENTS

NAME OF DEVICE	CIRCUIT SYMBOL	COMMONLY USED JUNCTION SCHEMATIC	ELECTRICAL CHARACTERISTICS		MAX RATINGS AVAILABLE	MAJOR APPLICATIONS	ROUGHLY ANALOGOUS TO:
Diode or Rectifier				Conducts easily in one direction, blocks in the other	1500 Amps 3000 Volts	Rectification Blocking Detecting Steering	Check valve Diode tube Gas diode
Avalanche (Zener) Diode				Constant voltage characteristic in negative quadrant	22 Volts 1 Watt	Regulation Reference Clipping	V-R tube
Integrated Voltage Regulator (IVR)				Programmed to desired V_{21} by two resistors 	40 Volts 100 mA 0.4 Watts	Shunt voltage regulator Reference element Error modifier Level sensing Level shifting	Avalanche Diode
Tunnel Diode				Displays negative resistance when current exceeds peak point current I_p	Peak point current = 100 mA Resistive cutoff freq. = 40 Gc	UHF converter Logic circuits Microwave circuits Level sensing	None
Back Diode				Similar characteristics to conventional diode except very low forward voltage drop	5 mA 400 mV	Microwave mixers and low power oscillators	None
Thyrector				Rapidly increasing current above rated voltage in either direction	70 A peak pulse (2" Sq. cell)	Transient voltage suppression and arc suppression	Thyrite Two avalanche diodes in inverse-series connection
n-p-n Transistor				Constant collector current for given base drive	300 Volts 25 Watts	Amplification Switching Oscillation	Pentode Tube
p-n-p Transistor				Complement to n-p-n transistor	75 Volts 25 Watts	Amplification Switching Oscillation	None
Photo Transistor				Incident light acts as base current of the photo transistor	45 Volts 0.25 Amps 0.6 Watts	Tape readers Card readers Position sensor Tachometers	None
Unijunction Transistor (UJT)				Unijunction emitter blocks until its voltage reaches V_p; then conducts	35 Volts 0.450 Watts	Interval timing Oscillation Level Detector SCR Trigger	None

MAJOR SEMICONDUCTOR COMPONENTS

NAME OF DEVICE	CIRCUIT SYMBOL	COMMONLY USED JUNCTION SCHEMATIC	ELECTRICAL CHARACTERISTICS		MAX RATINGS AVAILABLE	MAJOR APPLICATIONS	ROUGHLY ANALOGOUS TO:
Complementary Unijunction Transistor (CUJT)				Functional complement to UJT	30 Volts 0.30 Watts 0.15 Amps	High stability timers Oscillators and level detectors	None
Programmable Unijunction Transistor (PUT)				Programmed by two resistors for V_p, I_p, I_v. Function equivalent to normal UJT.	40 Volts 0.30 Watts 0.15 Amps	Low cost timers and oscillators Long period timers SCR trigger Level detector	UJT
Silicon Controlled Rectifier (SCR)				With anode voltage (+), SCR can be triggered by I_g, remaining in conduction until anode I is reduced to zero	1000 Amps 1800 Volts	Power switching Phase control Inverters Choppers	Gas thyratron or ignitron
Complementary Silicon Controlled Rectifier (CSCR)				Polarity complement to SCR	50 Volts 0.25 Amps 0.45 Watts	Ring counters Low speed logic Lamp driver	None
Light Activated SCR* (LASCR)				Operates similar to SCR, except can also be triggered into conduction by light falling on junctions	1.6 Amps 200 Volts	Relay Replacement Position controls Photoelectric applications Slave flashes	None
Silicon Controlled Switch* (SCS)				Operates similar to SCR except can also be triggered on by a negative signal on anode-gate. Also several other specialized modes of operation	100 Volts 200 mA	Logic applications Counters Nixie drivers Lamp drivers	Complementary transistor pair 
Silicon Unilateral Switch (SUS)				Similar to SCS but zener added to anode gate to trigger device into conduction at ~ 8 volts. Can also be triggered by negative pulse at gate lead.	0.350 Watts 0.200 Amps 10 Volts	Switching Circuits Counters SCR Trigger Oscillator	Shockley or 4-layer diode
Silicon Bilateral Switch (SBS)				Symmetrical bilateral version of the SUS. Breaks down in both directions as SUS does in forward.	0.350 Watts 0.200 Amps 10 Volts	Switching Circuits Counters TRIAC Phase Control	Two inverse Schockley diodes
Triac				Operates similar to SCR except can be triggered into conduction in either direction by (+) or (-) gate signal	25 Amps 500 Volts	AC switching Phase control Relay replacement	Two SCR's in inverse parallel
Diac Trigger				When voltage reaches trigger level (about 35 volts), abruptly switches down about 10 volts.	40 Volts 2 Amps peak	Triac and SCR trigger Oscillator	Neon lamp

*Light Activated SCS also available.

GLOSSARY OF WORDS, SYMBOLS AND ABBREVIATIONS

The following letter symbols and abbreviations are recommended by the Joint Electron Device Engineering Council (JEDEC) of the Electronic Industries Association (EIA) and the National Electrical Manufacturers Association (NEMA) for use in semiconductor device data sheets and specifications.

A, a —Anode
B, b —Base
b_{fs} —Common-source small-signal forward transfer susceptance
b_{is} —Common-source small-signal input susceptance
b_{os} —Common-source small-signal output susceptance
b_{rs} —Common-source small-signal reverse transfer susceptance
C, c —Collector
C_{cb} —Collector-base interterminal capacitance
C_{ce} —Collector-emitter interterminal capacitance
C_{ds} —Drain-source capacitance
C_{du} —Drain-substrate capacitance
C_{eb} —Emitter-base interterminal capacitance
C_{ibo} —Common-base open-circuit input capacitance
C_{ibs} —Common-base short-circuit input capacitance
C_{ieo} —Common-emitter open-circuit input capacitance
C_{ies} —Common-emitter short-circuit input capacitance
C_{iss} —Common-source short-circuit input capacitance
C_{obo} —Common-base open-circuit output capacitance
C_{obs} —Common-base short-circuit output capacitance
C_{oeo} —Common-emitter open-circuit output capacitance
C_{oes} —Common-emitter short-circuit output capacitance
C_{oss} —Common-source short-circuit output capacitance
C_{rbs} —Common-base short-circuit reverse transfer capacitance
C_{rcs} —Common-collector short-circuit reverse transfer capacitance
C_{res} —Common-emitter short-circuit reverse transfer capacitance
C_{rss} —Common-source short-circuit reverse transfer capacitance
C_{tc} —Collector depletion-layer capacitance
C_{te} —Emitter depletion-layer capacitance
D, d —Drain
E, e —Emitter
η —Intrinsic standoff ratio
f_{hfb} —Common-base small-signal short-circuit forward current transfer ratio cutoff frequency
f_{hfc} —Common-collector small-signal short-circuit forward current transfer ratio cutoff frequency
f_{hfe} —Common-emitter small-signal short-circuit forward current transfer ratio cutoff frequency
f_{max} —Maximum frequency of oscillation
F_T —Transition frequency (frequency at which common-emitter small-signal forward current transfer ratio extrapolates to unity)
G, g —Gate
g_{fs} —Common-source small-signal forward transfer conductance
g_{is} —Common-source small-signal input conductance
g_{MB} —Common-base static transconductance
g_{MC} —Common-collector static transconductance
g_{ME} —Common-emitter static transconductance
g_{os} —Common-source small-signal output conductance
G_{PB} —Common-base large-signal insertion power gain
G_{pb} —Common-base small-signal insertion power gain
G_{PC} —Common-collector large-signal insertion power gain
G_{pc} —Common-collector small-signal insertion power gain
G_{PE} —Common-emitter large-signal insertion power gain
G_{pe} —Common-emitter small-signal insertion power gain
G_{pg} —Common-gate small-signal insertion power gain
G_{ps} —Common-source small-signal insertion power gain
g_{rs} —Common-source small-signal reverse transfer conductance
G_{TB} —Common-base large-signal transducer power gain
G_{tb} —Common-base small-signal transducer power gain
G_{TC} —Common-collector large-signal transducer power gain
G_{tc} —Common-collector small-signal transducer power gain
G_{TE} —Common-emitter large-signal transducer power gain
G_{te} —Common-emitter small-signal transducer power gain
G_{tg} —Common-gate small-signal transducer power gain
G_{ts} —Common-source small-signal transducer power gain
h_{FB} —Common-base static forward current transfer ratio
h_{fb} —Common-base small-signal short-circuit forward current transfer ratio
h_{FC} —Common-collector static forward current transfer ratio
h_{fc} —Common-collector small-signal short-circuit forward current transfer ratio
h_{FE} —Common-emitter static forward current transfer ratio
h_{fe} —Common-emitter small-signal short-circuit forward current transfer ratio
h_{FEL} —Inherent large-signal forward current transfer ratio
h_{IB} —Common-base static input resistance
h_{ib} —Common-base small-signal short-circuit input impedance
h_{IC} —Common-collector static input resistance
h_{ic} —Common-collector small-signal short-circuit input impedance
h_{IE} —Common-emitter static input resistance
h_{ie} —Common-emitter small-signal short-circuit input impedance
$h_{ie(imag)}$ —Imaginary part of common-emitter small-signal short-circuit input impedance
$h_{ie(real)}$ —Real part of common-emitter small-signal short-circuit input impedance
h_{ob} —Common-base small-signal open-circuit output admittance
h_{oc} —Common-collector small-signal open-circuit output admittance
h_{oe} —Common-emitter small-signal open-circuit output admittance
$h_{oe(imag)}$ —Imaginary part of common-emitter small-signal open-circuit output admittance

$h_{oe(real)}$ —Real part of common-emitter small-signal open-circuit output admittance
h_{rb} —Common-base small-signal open-circuit reverse voltage transfer ratio
h_{rc} —Common-collector small-signal open-circuit reverse voltage transfer ratio
h_{re} —Common-emitter small-signal open-circuit reverse voltage transfer ratio
I_B —Base-terminal dc current
I_b —Alternating component (rms value) of base-terminal current
i_B —Instantaneous total value of base-terminal current
I_{BEV} —Base cutoff current, dc
$I_{B2(mod)}$ —Interbase modulated current
I_C —Collector-terminal dc current
I_c —Alternating component (rms value) of collector-terminal current
i_C —Instantaneous total value of collector-terminal current
I_{CBO} —Collector cutoff current (dc), emitter open
I_{CEO} —Collector cutoff current (dc), base open
I_{CER} —Collector cutoff current (dc), specified resistance between base and emitter
I_{CES} —Collector cutoff current (dc), base shorted to emitter
I_{CEV} —Collector cutoff current (dc), specified voltage between base and emitter
I_{CEX} —Collector cutoff current (dc), specified circuit between base and emitter
I_D —Drain current, dc
$I_{D(off)}$ —Drain cutoff current
$I_{D(on)}$ —On-state drain current
I_{DSS} —Zero-gate-voltage drain current
I_E —Emitter-terminal dc current
I_e —Alternating component (rms value) of emitter-terminal current
i_E —Instantaneous total value of emitter-terminal current
I_{EBO} —Emitter cutoff current (dc), collector open
I_{EB20} —Emitter reverse current
$I_{EC(ofs)}$ —Emitter-collector offset current
I_{ECS} —Emitter cutoff current (dc), base short-circuited to collector
$I_{E1E2(off)}$ —Emitter cutoff current
I_F —For voltage-regulator and voltage-reference diodes: dc forward current. For signal diodes and rectifier diodes: dc forward current (no alternating component)
I_f —Alternating component of forward current (rms value)
i_F —Instantaneous total forward current
$I_{F(AV)}$ —Forward current, dc (with alternating component)
I_{FM} —Maximum (peak) total forward current
$I_{F(OV)}$ —Forward current, overload
I_{FRM} —Maximum (peak) forward current, repetitive
$I_{F(RMS)}$ —Total rms forward current
I_{FSM} —Maximum (peak) forward current, surge
I_G —Gate current, dc
I_{GF} —Forward gate current
I_{GR} —Reverse gate current
I_{GSS} —Reverse gate current, drain short-circuited to source
I_{GSSF} —Forward gate current, drain short-circuited to source
I_{GSSR} —Reverse gate current, drain short-circuited to source
I_I —Inflection-point current
$Im(h_{ie})$—Imaginary part of common-emitter small-signal short-circuit input impedance
$Im(h_{oe})$—Imaginary part of common-emitter small-signal open-circuit output admittance
I_O —Average forward current, 180° conduction angle, 60-Hz half sine wave
I_P —Peak-point current
I_R —For voltage-regulator and voltage-reference diodes: dc reverse current. For signal diodes and rectifier diodes: dc reverse current (no alternating component)
I_r —Alternating component of reverse current (rms value)
i_R —Instantaneous total reverse current
$I_{R(AV)}$ —Reverse current, dc (with alternating component)
I_{RM} —Maximum (peak) total reverse current
I_{RRM} —Maximum (peak) reverse current, repetitive
$I_{R(RMS)}$ —Total rms reverse current
I_{RSM} —Maximum (peak) surge reverse current
I_S —Source current, dc
I_{SDS} —Zero-gate-voltage source current
$I_{S(off)}$ —Source cutoff current
I_V —Valley-point current
I_Z —Regulator current, reference current (dc)
I_{ZK} —Regulator current, reference current (dc near breakdown knee)
I_{ZM} —Regulator current, reference current (dc maximum rated current)
K, k —Cathode
L_c —Conversion loss
M —Figure of merit
NF_o —Overall noise figure
NR_o —Output noise ratio
P_{BE} —Power input (dc) to base, common emitter
p_{BE} —Instantaneous total power input to base, common emitter
P_{CB} —Power input (dc) to collector, common base
p_{CB} —Instantaneous total power input to collector, common base
P_{CE} —Power input (dc) to collector, common emitter
p_{CE} —Instantaneous total power input to collector, common emitter
P_{EB} —Power input (dc) to emitter, common base
p_{EB} —Instantaneous total power input to emitter, common base
P_F —Forward power dissipation, dc (no alternating component)
p_F —Instantaneous total forward power dissipation
$P_{F(AV)}$—Forward power dissipation, dc (with alternating component)
P_{FM} —Maximum (peak) total forward power dissipation
P_{IB} —Common-base large-signal input power
p_{ib} —Common-base small-signal input power
P_{IC} —Common-collector large-signal input power
p_{ic} —Common-collector small-signal input power
P_{IE} —Common-emitter large-signal input power
p_{ie} —Common-emitter small-signal input power
P_{OB} —Common-base large-signal output power
p_{ob} —Common-base small-signal output power
P_{OC} —Common-collector large-signal output power
p_{oc} —Common-collector small-signal output power
P_{OE} —Common-emitter large-signal output power
p_{oe} —Common-emitter small-signal output power
P_R —Reverse power dissipation, dc (no alternating component)
p_R —Instantaneous total reverse power dissipation
$P_{R(AV)}$—Reverse power dissipation, dc (with alternating component)

P_{RM} —Maximum (peak) total reverse power dissipation
P_T —Total nonreactive power input to all terminals
p_T —Nonreactive power input, instantaneous total, to all terminals
Q_S —Stored charge
r_{BB} —Interbase resistance
$r_b'C_c$ —Collector-base time constant
$r_{CE(sat)}$ —Saturation resistance, collector-to-emitter
$r_{DS(on)}$ —Static drain-source on-state resistance
$r_{ds(on)}$ —Small-signal drain-source on-state resistance
$\mathbf{Re(h_{ie})}$—Real part of common-emitter small-signal short-circuit input impedance
$\mathbf{Re(h_{oe})}$—Real part of common-emitter small-signal open-circuit output admittance
$r_{e1e2(on)}$—Small-signal emitter-emitter on-state resistance
r_i —Dynamic resistance at inflection point
R_θ —Thermal resistance
$R_{\theta CA}$ —Thermal resistance, case to ambient
$R_{\theta JA}$ —Thermal resistance, junction to ambient
$R_{\theta JC}$ —Thermal resistance, junction to case
S, s —Source
T_A —Ambient temperature or free-air temperature
T_C —Case temperature
t_d —Delay time
$t_{d(off)}$ —Turn-off delay time
$t_{d(on)}$ —Turn-on delay time
t_f —Fall time
t_{fr} —Forward recovery time
T_j —Junction temperature
t_{off} —Turn-off time
t_{on} —Turn-on time
t_p —Pulse time
t_r —Rise time
t_{rr} —Reverse recovery time
t_s —Storage time
TSS —Tangential signal sensitivity
T_{stg} —Storage temperature
t_w —Pulse average time
U, u —Bulk (substrate)
V_{BB} —Base supply voltage (dc)
V_{BC} —Average or dc voltage, base to collector
v_{bc} —Instantaneous value of alternating component of base-collector voltage
V_{BE} —Average or dc voltage, base to emitter
v_{be} —Instantaneous value of alternating component of base-emitter voltage
$V_{(BR)}$ —Breakdown voltage (dc)
$v_{(BR)}$ —Breakdown voltage (instantaneous total)
$V_{(BR)CBO}$ —Collector-base breakdown voltage, emitter open
$V_{(BR)CEO}$ —Collector-emitter breakdown voltage, base open
$V_{(BR)CER}$ —Collector-emitter breakown voltage, resistance between base and emitter
$V_{(BR)CES}$ —Collector-emitter breakdown voltage, base shorted to emitter
$V_{(BR)CEV}$ —Collector-emitter breakdown voltage, specified voltage between base and emitter
$V_{(BR)CEX}$ —Collector-emitter breakdown voltage, specified circuit between base and emitter
$V_{(BR)EBO}$ —Emitter-base breakdown voltage, collector open
$V_{(BR)ECO}$ —Emitter-collector breakdown voltage, base
$V_{(BR)E1E2}$ —Emitter-emitter breakdown voltage
$V_{(BR)GSS}$ —Gate-source breakdown voltage
$V_{(BR)GSSF}$—Forward gate-source breakdown voltage
$V_{(BR)GSSR}$—Reverse gate-source breakdown voltage
V_{B2B1} —Interbase voltage
V_{CB} —Average or dc voltage, collector to base
v_{cb} —Instantaneous value of alternating component of collector-base voltage
$V_{CB(fl)}$ —Collector-base dc open-circuit voltage (floating potential)
V_{CBO} —Collector-base voltage, dc, emitter open
V_{CC} —Collector supply voltage (dc)
V_{CE} —Average or dc voltage, collector to emitter
v_{ce} —Instantaneous value of alternating component of collector-emitter voltage
$V_{CE(fl)}$—Collector-emitter dc open-circuit voltage (floating potential)
V_{CEO} —Collector-emitter voltage (dc), base open
$V_{CE(ofs)}$ —Collector-emitter offset voltage
V_{CER} —Collector-emitter voltage (dc), resistance between base and emitter
V_{CES} —Collector-emitter voltage (dc), base shorted to emitter
$V_{CE(sat)}$ —Collector-emitter dc saturation voltage
V_{CEV} —Collector-emitter voltage (dc), specified voltage between base and emitter
V_{CEX} —Collector-emitter voltage (dc), specified circuit between base and emitter
V_{DD} —Drain supply voltage (dc)
V_{DG} —Drain-gate voltage
V_{DS} —Drain-source voltage
$V_{DS(on)}$ —Drain-source on-state voltage
V_{DU} —Drain-substrate voltage
V_{EB} —Average or dc voltage, emitter to base
v_{eb} —Instantaneous value of alternating component of emitter-base voltage
$V_{EB(fl)}$—Emitter-base dc open-circuit voltage (floating potential)
V_{EBO} —Emitter-base voltage (dc), collector open
$V_{EB1(sat)}$—Emitter saturation voltage
V_{EC} —Average or dc voltage, emitter to collector
v_{ec} —Instantaneous value of alternating component of emitter-collector voltage
$V_{EC(fl)}$—Emitter-collector dc open-circuit voltage (floating potential)
$V_{EC(ofs)}$ —Emitter-collector offset voltage
V_{EE} —Emitter supply voltage (dc)
V_F —For voltage-regulator and voltage-reference diodes: dc forward voltage. For signal diodes and rectifier diodes: dc forward voltage (no alternating component)
V_f —Alternating component of forward voltage (rms value)
V_F —Instantaneous total forward voltage
$V_{F(AV)}$—Forward voltage, dc (with alternating component)
V_{FM} —Maximum (peak) total forward voltage
$V_{F(RMS)}$—Total rms forward voltage
V_{GG} —Gate supply voltage (dc)
V_{GS} —Gate-source voltage
V_{GSF} —Forward gate-source voltage
$V_{GS(off)}$ —Gate-source cutoff voltage
V_{GSR} —Reverse gate-source voltage
$V_{GS(th)}$ —Gate-source threshold voltage
V_{GU} —Gate-substrate voltage
V_I —Inflection-point voltage
V_{OB1} —Base-1 peak voltage
V_P —Peak-point voltage
V_{PP} —Projected peak-point voltage
V_R —For voltage-regulator and voltage-reference diodes: dc reverse voltage. For signal diodes and rectifier diodes: dc reverse voltage (no alternating component)
V_r —Alternating component of reverse voltage (rms value)

v_R —Instantaneous total reverse voltage
$V_{R(AV)}$ —Reverse voltage, dc (with alternating component)
V_{RM} —Maximum (peak) total reverse voltage
V_{RRM} —Repetitive peak reverse voltage
$V_{R(RMS)}$—Total rms reverse voltage
V_{RSM} —Nonrepetitive peak reverse voltage
V_{RT} —Reach-through voltage
V_{RWM}—Working peak reverse voltage
V_{SS} —Source supply voltage (dc)
V_{SU} —Source-substrate voltage
$V_{(TO)}$ —Threshold voltage
V_V —Valley-point voltage
V_Z —Regulator voltage, reference voltage (dc)
V_{ZM} —Regulator voltage, reference voltage (dc at maximum rated current)
y_{fb} —Common-base small-signal short-circuit forward transfer admittance
y_{fc} —Common-collector small-signal short-circuit forward transfer admittance
y_{fe} —Common-emitter small-signal short-circuit forward transfer admittance
y_{fs} —Common-source small-signal short-circuit forward transfer admittance
$y_{fs(imag)}$—Common-source small-signal forward transfer susceptance
$y_{fs(real)}$ —Common-source small-signal forward transfer conductance
y_{ib} —Common-base small-signal short-circuit input admittance
y_{ic} —Common-collector small-signal short-circuit input admittance
y_{ie} —Common-emitter small-signal short-circuit input admittance
$y_{ie(imag)}$—Imaginary part of small-signal short-circuit input admittance (common-emitter)
$y_{ie(real)}$ —Real part of small-signal short-circuit input admittance (common-emitter)
y_{is} —Common-source small-signal short-circuit input admittance
$y_{is(imag)}$—Common-source small-signal input susceptance
$y_{is(real)}$—Common-source small-signal input conductance
y_{ob} —Common-base small-signal short-circuit output admittance
y_{oc} —Common-collector small-signal short-circuit output admittance
y_{oe} —Common-emitter small-signal short-circuit output admittance
$y_{oe(imag)}$—Imaginary part of small-signal short-circuit output admittance (common-emitter)
$y_{oe(real)}$ —Real part of small-signal short-circuit output admittance (common-emitter)
y_{os} —Common-source small-signal short-circuit output admittance
$y_{os(imag)}$—Common-source small-signal output susceptance
$y_{os(real)}$ —Common-source small-signal output conductance
y_{rb} —Common-base small-signal short-circuit reverse transfer admittance
y_{rc} —Common-collector small-signal short-circuit reverse transfer admittance
y_{re} —Common-emitter small-signal short-circuit reverse transfer admittance
y_{rs} —Common-source small-signal short-circuit reverse transfer admittance
$y_{rs(imag)}$—Common-source small-signal reverse transfer susceptance
$y_{rs(real)}$ —Common-source small-signal reverse transfer conductance
z_{if} —Intermediate-frequency impedance
z_m —Modulator-frequency load impedance
z_{rf} —Radio-frequency impedance
$Z_{\theta JA(t)}$—Junction-to-ambient transient thermal impedance
$Z_{\theta JC(t)}$—Junction-to-case transient thermal impedance
$Z_{\theta(t)}$ —Transient thermal impedance
z_v —Video impedance
z_z —Regulator impedance, reference impedance (small-signal at I_z)
z_{zk} —Regulator impedance, reference impedance (small-signal at I_{ZK})
z_{zm} —Regulator impedance, reference impedance (small-signal at I_{ZM})

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